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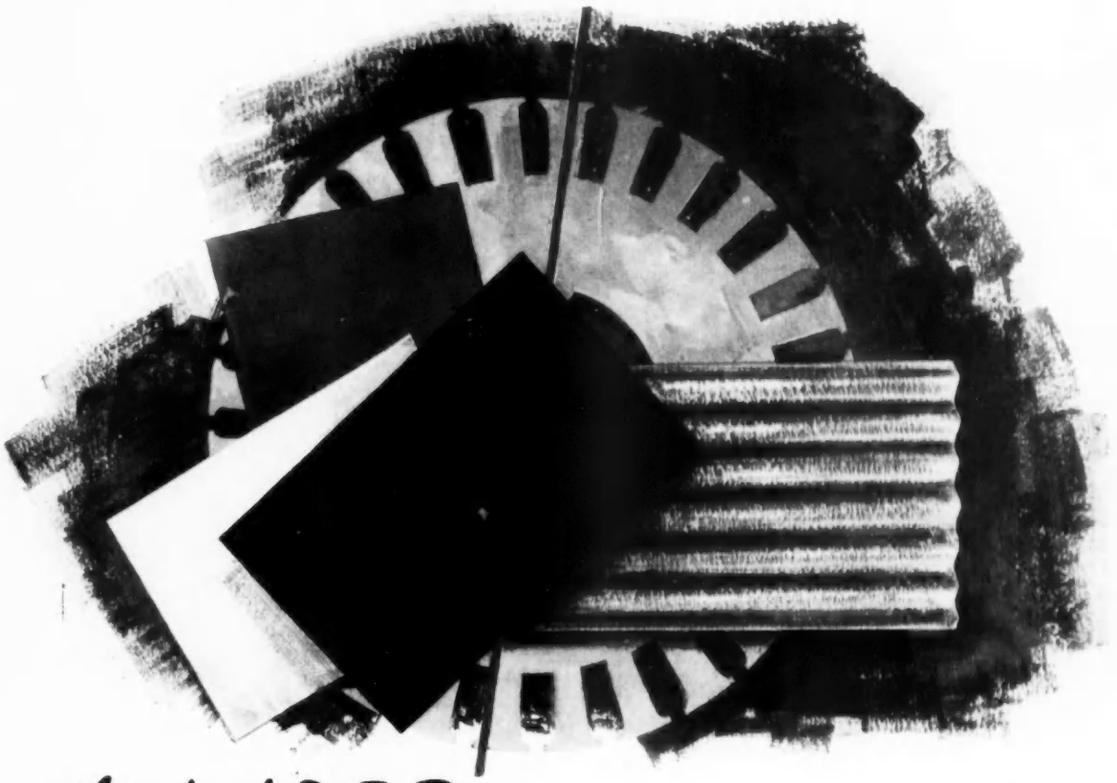

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THE ENGINEER

No. 5502 JULY 7, 1961 Vol. 212

A COMMISSION'S SWANSONG?

There is not much to say about the Report of the British Transport Commission for the year ending December 31, 1960. It reveals nothing unexpected and says very much what it could be expected to say. British Railways made an operational deficit of £67·7 millions and, allowing for surpluses on other activities of the Commission, notably under the headings Docks, Harbours and Wharves, and Letting of Land and Buildings not in Operational use, the working deficit was £36·3 millions. To this there must be added interest and other central charges amounting to £45 millions for British Railways and £19·6 for the others, yielding an overall deficit of of £100·9 millions. How very seriously the railways are in the red can be appreciated from the statistic that the operational deficit of £67·7 millions amounts to some 6 per cent of the gross receipts. To balance the accounts — even on the optimistic assumption that outgoings would not increase — the railways would have to carry some ten per cent more passengers and freight than they do at present without any increase of manpower. The depressing outcome of the year is largely to be accounted for as an effect of the recommendations of the Guillebaud Committee that substantial increases in wages should be granted to railwaymen, substantially larger than the Commission had counted upon. In an industry in which labour costs represent over 60 per cent of the total working expenditure wage increases, of course, weigh especially heavily. No wonder work study is beginning to be applied to railway traffic operations! Many people will be tempted to express surprise that it was not vigourously applied years ago. But an explanation may be concealed in the sentence "at the end of 1960 it was given a new impetus with the support of the trade unions who recognise the benefits to be obtained". The rank and file of railwaymen may at last be beginning to see the red light. Unless deficits on railway operations can be eliminated or at least reduced to much more manageable proportions it is not easy to be confident of the power of railways to survive the impact of road competition except perhaps for commuting traffics. But if the railway unions press for higher wages as they seem likely to in the near future deficits must increase unless productivity rises.

The Report also comments, of course, on the progress of the modernisation plan; but it has really very little fresh to say. It is pointed out that the competition of "C" licensed vehicles has depressed the price at which freight transport can be sold; there is the familiar plaint about the intensification of peak commuting traffic; it is explained that the benefit of substituting diesels for steam locomotives, of introducing modern stock, of building new freight yards and improving signalling etc. cannot be felt, and, indeed, may prove illusory, until the work of modernisation has been completed over very large operational areas; and there is the usual remark about the "fundamental problem" of "reconciling the growth and freedom of private transport with the need to preserve public services which are healthy and efficient." Interestingly in this section of the Report we seem to detect a faintly defensive ring. No doubt it has crept in because fundamental changes in the whole structure of the Commission are foreshadowed. "The present Report is . . . likely to be the last in which the Commission describe the progress and policies of the existing organisation." It cannot but be a disappointment to the existing Commission that the modernisation plan has not so far made the railways profitable but has seen the accounts move deeper into the red. With a slight air of defiance there are added the words "It is perhaps desirable to add that in the Commission's view nothing has happened, either technically or as regards economics or timing, to falsify the various expectations put upon the Modernisation Plan; they stand by their statement in the Re-appraisal that railway modernisation is a sound investment from the country's point of view."

AGRICULTURAL ENGINEERING

That many problems still face designers, salesmen and users of agricultural machinery is well demonstrated by the impressive array of machinery and equipment displayed over the 170-acre site of this year's Royal Show at Cambridge. One which presents an interesting challenge to the skill of the engineer is that of the design of the potato harvester. Many harvesters are on the market, and their methods of getting the potato from beneath the ground and into the sack vary widely. But we gather from conversations with farmers, that when casual labour can be hired at the right time of the year a potato spinner followed by labour lifting the crop by hand can often prove a more worthwhile economic proposition: present designs of potato harvesters are expensive and still need to be waited upon by many subsidiary manual labourers.

It is not solely the task of engineers to solve other problems facing the industry. Selling, and particularly selling abroad, provides a very real challenge. The Agricultural Engineers' Association reported recently that exports of agricultural tractors and machinery to the European Continent for the past two years have maintained a consistent pattern. But it also reported that imports of combine harvesters from Western Germany into this country must be regarded as a serious threat to United Kingdom manufacturers. Imports of combines in the first five months of this year rose by no less than 150 per cent, the bulk coming from Western Germany. On the other hand, the Export Council for Europe, as recently as June 25, published a report on trading opportunities in Western Germany in which it said that Germany's door is still wide open to British exporters provided the quality, price and technical efficiency are right. Agriculture in Western Germany, it added, is so far not as highly mechanised as in Britain and there is, therefore, a growing market for all types of machinery and implements. Any agreement within the European Economic Community which might expose

German agriculture to greater competition from its partners would tend to accelerate the trend towards mechanisation. Britain contributed 41·1 per cent of the needs of this section of the German market in 1959, but this proportion sank to 36·3 per cent in 1960.

There are mixed feelings amongst agricultural engineering firms about the value of showing their products at exhibitions. On the one hand it does bring technical men into contact with actual and prospective customers. On the other hand it is, of course, a costly business. Probably it is essential to take space at a proportion of all appropriate exhibitions. What that proportion should be is wrapped up with a firm's policy. It may well be that the importance of the part played by salesmen has been too much played down. In his presidential address to the Federation of British Industries recently, Sir William McFadzean said that he sometimes wondered if the virtue of being a scientist, a technician, a production efficiency expert, &c., had been overboosted for many years relative to being a salesman. Too often in this, and possibly other countries, Sir William said the belief was held than any 'dogsbody' could go on the commercial side. It may well be that poor salesmanship contributes to the way Britain's proportion of agricultural machinery sales to Europe is sagging.

A CHALLENGE TO BUILDERS

Those aspects of the Building Research Station's work within the field of civil engineering — such as in soil mechanics and in steel structures — are well known in the engineering profession; together with the other parts of the Station's work, they are reviewed in "Building Research 1960" which has just been published by H.M. Stationery Office. Referring to the "building industry" however, the Building Research Board has this to say: "It is clear to us from the enquiries that reach the Station that neither the professions nor contractors make anything like full use of the information at present available. There is no doubt that the capacity to absorb and utilise new knowledge and therefore the types of information and advisory services which the industry requires, are closely linked with the educational level of people in the industry. . . . We believe that an immediate and important step forward in the technical efficiency of most building firms would be the allocation to one senior member of the staff of the duty of keeping up-to-date with technical matters."

In an industry where around 30 per cent of firms employ no operatives, and over 80 per cent ten or less, the Board's advice is clearly limited in scope! The building industry, however, seems to have an almost superhuman resistance to change, and the countless small jobs of repair etc., continue to be done traditionally, and therefore, presumably expensively, to say nothing of more ambitious tasks. Yet overall, "construction" (i.e. building and civil engineering together, excluding repairs and maintenance) accounts for almost half the nation's capital investment. What scope there must be for improvement and rationalisation in this vast industry!

LIVING WITH AUTOMATION

In emphasising the necessity of automation for our national future when opening the "Automation—Men and Money" conference at Harrogate on June 27, Lord Hailsham related it to processes as old as industry. He reminded this meeting of the British Conference on Automation and Computation that from the first industrialisation had involved the substitution of mechanical for manual operation. Automation was only the extension of this process to design, transfer, control and inspection, and finally to the whole process of manufacture, by modern means of electronic control and computation. Unlike the original industrialisation, automation extended to the office not less than to the factory, to the bank and the counting house not less than to the shop floor. He went on to show that this process would make more, not less, opportunities for skilled employment, and that this was the result of all labour-saving devices. To realise the force of what Lord Hailsham said, one has only to think of what followed the development of the steam engine valve gear as the replacement for manual operation. In the present age the electronic valve has made automation feasible because it can change between conducting and non-conducting states far more rapidly than any device known before, and now this, in turn, is being outstripped in speed by the transistor. Perhaps automation is easier to accept to-day because we work at speeds acknowledged by all to be beyond the capacity of human brain and muscle.

The process of automation, Lord Hailsham said, would lead to changes in the pattern of employment. A new army of maintenance technicians would be substituted for the army of operators. This would have a vast effect upon our whole system of education and technical training. What was required was a thorough-going consideration of this subject by and within the universities themselves, and an increased interest in industry in the nature of the courses available both in the universities and in the college of advanced technology, with an increased demand for the products of those courses. He hoped one result of the conference might be that fresh material might be placed before the university authorities, or before the inquiry into higher education which was now in progress.

PLASTICS

The growth of the plastics industry has been extremely rapid over the past decade and a good indication of the present stage of development was given at the International Plastics Exhibition, which closed last Saturday, where the latest products and manufacturing plant of nearly five hundred firms from this and other countries were displayed. The new materials and products showed how the field of application for plastics is steadily widening and how plastics are making inroads into the commercial and domestic markets long held by conventional materials. It was probably in the variety of products and many plastic materials now available that the main interest of the exhibition centred, although manufacturers were able to see a wide selection of plant of improved designs giving increased capacities and speeds and having simplified and automatic means of control.

The way in which plastics goods are now being designed to combine a high standard of appearance with inherent functional properties was in evidence at the exhibition. But even so it was noticeable that in some cases where plastics were being used to replace conventional materials the designs departed but little from the conventional practice in the goods themselves. This is a point of importance for unless the designer of industrial equipment works closely with the specialist in plastics the best qualities of the newer materials are not fully used and difficulties and disappointments in performance can quickly follow. Indeed a tendency in the past to follow orthodox designs when introducing plastics has

resulted in failures which have deterred their wider adoption. There has also in the past been a tendency by some concerns to make claims for plastics in certain applications which have not been borne out in service. Efforts should always be made by manufacturers of both plant and materials to ensure that their claims can be substantiated, otherwise the progress of the plastics industry, which is still in its infancy, will inevitably be slowed down.

POWER IN SPACE

One of the three satellites launched simultaneously from Cape Canaveral on June 29 by a single "Thor-Able-Star" rocket breaks new ground in the problem of space power supplies by incorporating a thermo-electric generator using a small cylinder of plutonium 238 as the source of heat. The unit weighs 4½lb, and officials of the United States Atomic Energy Commission stated that conventional batteries and solar cells to produce the same output would have to weigh many times more. The converter, which operates two radio transmitters and other instruments, is said to be capable of generating 2½W for several years. This satellite is a navigational device forming the first operational prototype of the U.S. Navy's satellite navigation programme. The plan, due to be implemented late next year, is for four satellites in spaced orbits, their transmissions providing a high-accuracy fixing system for ships, submarines and aircraft. The navigational satellite, known as "Transit 4A", had mounted upon it at the launch a drum-shaped satellite "Injun" weighing 40 lb, for studies of the radiation belt round the earth, and a 55 lb sphere, "Greb", for measurement of solar X-rays. The three satellites went into orbit and are circling the earth between 550 miles and 620 miles in space. Although the smaller pair failed to separate, the simultaneous launching was itself an achievement, but it is secondary in interest to the vista of possibilities implicit in the new lightweight source of power carried by "Transit A4".

NOW IS THE TIME

To celebrate the fiftieth anniversary of the Ford Motor Company, Ltd., last Saturday the Dagenham Car Club organised a motor cavalcade. In brilliant sunshine a great variety of vehicles assembled, the spotless paint and gleaming polish of the majority bearing witness to the enthusiasm of private owners, although there was evidence also of the proclivity for advertisement of a native motor corporation. But the composition of the concourse clearly showed an unwelcome distortion: the vehicles were either "vintage," such as the numerous English-assembled models "T" and "B", or virtually contemporary. The presence of the older vehicles yields, of course, not only pleasure — the reek of castor oil as a Bertelli Aston Martin spins its tyres on dry grass, the chuckle of a "Flying Squirrel" joyously wiggle-woggling a row of flags! — but also profit — the Dearborn designs demonstrated, decades since, gearboxes resistant to abuse, transmissions with no moving parts exposed, and lighting systems with but one control lever. But the most desirable quality in a relic is authenticity, and so one is dismayed to contemplate the great gap in the cavalcade which, it seems, will have to be filled by laborious restoration of, probably, neglected and incomplete examples. For instance, the "Surrey" was present only in the spirit, as a third axle conversion of a "Trader". We saw not a single full-forward-control Thames, either civilian or four-wheel drive, nor an example of the essential Vee-8 with the eight-lobe-cam double-contact-breaker (still widely incomprehended!) ignition unit. Two examples of the original "Popular" were there to remind us that the "100E" was not the first version of this model to have separate head and side lights, but the only example of the severe elegance of the original "Anglia" was an official's car and did not take part in the cavalcade. Neither the sleek and spacious 94in saloon nor the design that is probably the finest achievement of Dagenham, the asymmetrical 10 h.p. 10cwt, were among the entries, although both were to be seen on the roads of the neighbourhood, the latter, notably enough, in the shape of two examples of the classical configuration, with central throttle and right-hand brake lever, built before the war. If important designs such as these are to be preserved for posterity in such a condition that their qualities can accurately be assessed, the easy way so to do is to act now, before unmodified examples become scarce: rebuilding a wreck as a replica, satisfying as it may be, is exceedingly extravagant of precious enthusiasm. In the case of commercial vehicles some encouragement in this direction is given by the Historic Commercial Vehicle Club, which reserves some of its trophies for vehicles built in 1931 or later, but it is apparent that far more people could and would participate in preservation were it realised more widely that within a few short years the "Gloria" and the "Retriever," the "Black Prince" and the "Silver Arrow," will be of historic importance.

The Engineer—100 Years Ago (JULY 5, 1861)

"Military Ballooning"

"The advices to hand by the Australia on Saturday state that an experiment in aerial telegraphy for military purposes had been made successfully at Washington. There is nothing new in military ballooning—the battle of Fleurus, in 1794 or 1795, having been decided in favour of the French mainly through the information which they derived from the clouds as to the enemy's movements. *Revenons á nos moutons Americains.* It appears that on the 18th ult. Professor Lowe—who, by-the-bye, has not yet got across the Atlantic in a balloon voyage—ascended from the Armory lot. The capacity of the balloon was 20,000 cubic feet. It was provided with signal flags and a powerful telescope; but as the ascent was made late in the afternoon, and chiefly for the purpose of testing the practicability of maintaining a magnetic circuit and operating in the balloon, no reconnaissance was attempted. A circuit was established by looping one of the adjacent telegraph wires—the one between Alexandria and the War Department—with helix wires several hundred feet in length, wound upon a reel at the spot from which the ascent was made. The helix wires are very fine and flexible. They communicated with a delicate pocket Morse apparatus carried by the operator in the balloon. The helices were paid out from the reel as rapidly as the ropes attached to the balloon. An ascent of 500ft or 600ft was made, and the telegraphic arrangement worked charmingly."

Off-the-Road Locomotion

By R. M. OGORKIEWICZ, M.Sc.(Eng.), A.M.I.Mech.E.

No. I

The First International Conference on the Mechanics of Soil Vehicle Systems was held in Turin and Saint Vincent, Italy, from June 12 to 16. A wide range of subjects relating to off-the-road locomotion was covered, and the first part of the following review deals with some of the material presented at the conference.

GROWING interest in land locomotion and recent research into the relationships between vehicles and the soil on which they operate provided ample reason for the first International Conference on the Mechanics of Soil Vehicle Systems held in Turin from June 12 to 16. The initiative in calling the conference came largely from the United States, where most of the work on land locomotion has been done so far, but the location of the conference was prompted by some independent work done in this field in Italy. Eventually, the conference was sponsored by the General Inspectorate of Motorisation of the Italian Army and the U.S. Army Research Office, as well as the U.S. Army Ordnance Tank-Automotive Command Land Locomotion Laboratory, and it was organised by the Technological University of Turin. Some 320 delegates from seventeen different countries attended the conference and it is of interest to note that after the local, Italian, contingent the next largest came from the United States and that it was almost as large as all the other non-Italian groups put together, indicating clearly the interest of the U.S. Army, industry and academic institutions in land locomotion. What is more, most of the papers presented for discussion were by American authors and the conference largely amounted to a presentation of the results of American investigations which were generously made available to others.

Theoretical Analyses

The first of the opening series of papers, "On Stress-Strain Relations for Soils and Load Carrying Capacity," by D. C. Drucker, of Brown University, emphasised the youthfulness of the science of soil mechanics and the lack, as yet, of general relationships between stress and strain for soils in such cases as those of bearing capacity and land locomotion over weak terrain, which lie within the realm of plasticity. Existing forms of plasticity theory do not apply. This has been demonstrated by the results obtained by D. J. Henkel in triaxial tests on clays at the Imperial College of Science, which show that preconsolidation pressure and the existing state of stress determine the state of the soil and which contradict the existing form of theory. Another indication that conventional plasticity theory does not apply fully to soils is that the stress-strain curves for soils generally reach a maximum and then fall off. Loose sand and remoulded clay behave more in accordance with conventional stress-strain relationships, but dense sand and undisturbed clay peak very markedly, and theory cannot provide a suitable description of behaviour in such cases. However, while a complete solution is well beyond present understanding, the author considered that the lesser but more useful goal of determining the load which will cause failure of an inelastic soil mass and, consequently, its load carrying capacity was attainable. In particular, reasonably close bounds to load carrying capacity could be obtained for perfectly plastic soil using the technique based on the two propositions known as the theorems of limit analysis, introduced by him and Prager in 1952.* The Lower Bound Theorem states, in effect, that the soil mass will not fail if an equilibrium stress distribution can be found which balances the applied load and for which the yield condition is nowhere exceeded; the Upper Load Bound Theorem postulates that failure must occur if, for any compatible pattern of plastic deformation, the rate at which external forces do work exceeds the rate of internal dissipation. In the case of work-hardening soils serious difficulties arise and the second theorem has no meaning because the deformation pattern does not determine the dissipation uniquely. Similar difficulties arise with frictional soils in which case, moreover, the first theorem does not hold.†

An example of the application of limit analysis was given in "Methods of Plasticity in Land Locomotion Studies," by R. M. Haythornthwaite, of the University of Michigan. It confined itself to the relatively simple case of an "L"-shaped grouser plate simulating a track plate with a lug and used the generally accepted Coulomb yield condition, i.e. that slip occurs in the soil when on any plane in the soil shear stress reaches the value

$$s = c - p \tan \phi$$

where c is the cohesion, p the normal (tensile) stress on the plane and ϕ is a second empirical constant called the angle of internal friction. The paper illustrated that by choosing, by intuition, suitably complex admissible stress fields the upper and lower bounds may lie sufficiently close together over a range of values of the ratio of horizontal to vertical forces on the track plate to provide an indication of load carrying capacity under the given conditions. As pointed out by the author of the paper, the application of plasticity methods stands or falls on the appropriateness of the assumed yield condition and the stress-strain law, and there is need for much further experimental research in this field. Even for sands the Coulomb law has not been fully confirmed and until these fundamental questions are resolved great caution must be exercised in applying plasticity theory. Nevertheless, its concepts have already proved useful in land locomotion in elucidating, for instance, the problem of the spacing of wheels and tracks to prevent interaction between slip zones.‡

A different aspect of land locomotion was outlined in the "Analysis of the Displacements of the Ground Surface Due to a Moving Vehicle," by R. L. Shiffman, of the Rensselaer Polytechnic Institute. In this case it was assumed that the stresses imposed on the soil never reached its shear strength; the soil considered was clay, which follows linear laws for small strains and whose behaviour was represented by visco-elastic models. From these the time-displacement relationship was developed for the vehicle which was treated as a loaded plate subjected to repetitive loading. The conclusions stated were that deformation under light vehicles when parked followed a Kelvin visco-elastic relation and, as might have been deduced from field observations, could be controlled within tolerable limits by adjusting the loaded area; on the other hand, under heavy vehicles where soil behaviour was taken to follow Kelvin visco-elasticity augmented by purely viscous deformation, deformation could only be controlled by restricting the time of parking. Light fast-moving vehicles were concluded to impose only elastic deformations on the ground but for a relatively slow traverse of the ground the same light vehicle will permit time dependent deformations and, in general, the longer the time of passage the greater the deformation. This type of behaviour implies an instantaneous elastic deformation followed by an additional viscous deformation and is represented by the five-element visco-elastic model shown in Fig. 1(*a*). In the case of heavy vehicles moving over soft terrain the behaviour is represented by a three-element visco-elastic model shown in Fig. 1(*b*) and any limiting deformation is approached exponentially with load and time of deformation. In theory, therefore, a balance must be reached between load and speed: higher loads require greater speeds for a given deformation. It is worth adding that this paper, like the previous two, was based on work sponsored by the Land Locomotion Laboratory of the U.S. Army Ordnance Tank-Automotive Command.

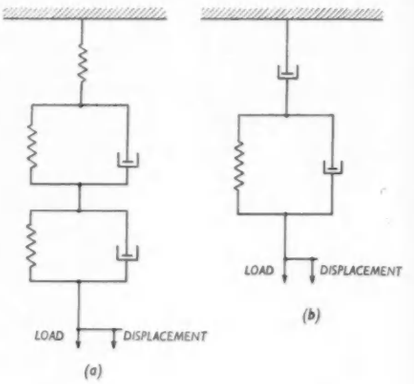


Fig. 1(*a*)—Five element visco-elastic model

Fig. 1(*b*)—Three element visco-elastic model

Yet another theoretical treatment was presented in a paper on the "Elastic Response of Soil to Tracked Vehicles," by E. T. Selig, K. E. Hofer and N. A. Weil of the Armour Research Foundation. As in the previous paper, a homogeneous, isotropic, linear elastic material was assumed but the vehicle was stationary so that time derivatives of stress and strain were not involved. The vehicle loading on the surface of the soil was represented by a uniform pressure distribution over two parallel rectangular areas; this was done to simplify theoretical analysis, but it was claimed that the assumed distribution gave results identical to that of the more realistic but much more involved non-uniform distribution, except for a small region immediately beneath the load. On this basis, strains were computed at various locations in the soil by superposition of

* Drucker, D. C., Prager, W. and Greenberg, H. J., "Extended Limit Design Theorems for Continuous Media," *Quarterly of Applied Mathematics*, Vol. 9, January, 1952, pages 381-389.

† Drucker, D. C., "Coulomb Friction, Plasticity and Limit Loads," *Journal of Applied Mechanics*, Vol. 21, 1954, pages 71-74.

‡ Bekker, M. G., "Theory of Land Locomotion," University of Michigan Press, Ann Arbor, 1956.

values derived from A. E. H. Love's solution§ for the two rectangular areas. Results were then compared with experimental measurements of soil strain, or rather differential displacement, the displacement sensing elements of the gauges buried in the soil being of the linear differential transformer type capable of detecting displacements as small as 0·0001in over a range of ½in. The location of the gauges is shown in Fig. 2 and the tests were performed in two soils, one a silty clay and the other a plastic clay, the maximum surface pressure applied in each case being well below the soil bearing capacity.

As there were twelve gauges, this provided twelve independent sets of equations from which to determine the two unknowns, the modulus of elasticity and Poisson's ratio, which would completely describe the properties of the assumed material, and if the soil does respond according to the elastic theory then, except for experimental error, a single pair of values should have satisfied all twelve equations. The extent of agreement is shown in Fig. 3, where the relationship between the modulus of elasticity and Poisson's ratio are plotted for each gauge. The curves obviously do not intersect at a single point for each soil but, excluding gauges 5 and 12 in plastic clay and bearing in mind other practical difficulties, the regions of intersection of the curves are fairly well delineated, and on the strength of this the authors consider that the theory of elasticity can be used to predict displacements and, consequently, strains and stresses in the soil under moderate loading conditions. The evidence may not be entirely convincing, but the paper presents an interesting possibility, for some lightly loaded soils at any rate.

Experimental Work

Up till now the methods indicated by the above papers have found little practical use. The principal methods used in the analysis of soil-vehicle behaviour are based on the less sophisticated but much more practical approach established by M. G. Bekker, who was the head of the U.S. Army's Land Locomotion Laboratory from its beginnings until last year and who is now head of the new Land Mobility Laboratory of the General Motors Corporation. This approach is based on semi-empirical load-sinkage and shear-slip relationships. In their simplest form, for a long rectangular loading plate, these are :

$$p=\left(\frac{k_c}{b}+k_\phi\right)z^n$$

and

$$H_{max}=Ac+W\tan\phi$$

where

W = Normal load, lb
p = Normal pressure, lb/in²
H = Thrust or tractive effort, lb
b = Width of loading plate or ground contact area, inch
A = Ground contact area, in²
z = Sinkage of loading plate, inch
c = Cohesion, lb/in²
ϕ = Angle of internal friction, deg.
k_c = Cohesive modulus of sinkage, lb/in^{n+1}
k_ϕ = Frictional modulus of sinkage, lb/in^{n+2}
n = Exponent of sinkage

A number of different techniques may be used to measure the physical soil values. The method used by the Land Locomotion Laboratory is based on an instrument called the Bevameter, which employs a shear annulus and loading plates ; the shear annulus or ring is rotated at three or more normal loads for each of which a record is obtained of the shearing force v. the angular position of the ring ; there must be two different size loading plates, either circular or rectangular with a width to length ratio of 1:5 to 1:10, and they are forced into the soil, a record being obtained for each of pressure v. sinkage. The instrument is hydraulically operated and its name derives from "Bekker Value Meter." A similar instrument has also been developed and used at the Agricultural Research Centre Braunschweig-Volkenrode, in Germany, as described by W. Sohne and F. J. Sonnen in their paper "Comparison Between Relationships of Agricultural Tractors and Mechanical Soil Values."

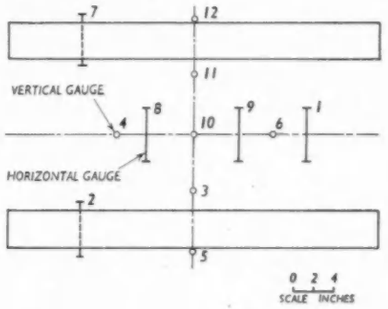


Fig. 2—Location of gauges for field test

A drawback with this type of instrument is that the test cycle can not be reduced to less than about ten minutes, which makes it difficult to obtain the amount of data necessary for statistical analysis of soil values. To overcome this difficulty, a much quicker and continuous method has been proposed by M. G. Bekker and described in "Bevameter 100 : a New Type of Field Test Apparatus for Measuring Locomotive Stress-Strain Relationships in Soils," by F. Pavlics, who worked on it at the Land Locomotion Laboratory, but who is now with the General Motors Corporation. The new method is based on the use of two rigid rolling wheels having the same diameter but different widths, instead of the two loading plates previously used, and having the circumference of such wheels fitted with grouser plates so that they can be used instead of the spudded shear ring.

A schematic drawing of such a wheel-type device for determining sinkage soil parameters is shown in Fig. 4, which shows two loaded wheels of different widths and, between them, a reference wheel of the same diameter as the others but counterbalanced almost to zero load so that it rolls on the surface of the soil ; the wheels are free to rotate on arms pivoted on a towing carriage. The sinkage of the two loaded wheels is measured by linear potentiometers with a range of 0 to 8in, using the reference wheel as base. The two sets of results are then used in conjunction with the following equation for the sinkage of a rigid wheel of diameter D and width b,‖ to obtain the soil sinkage parameters k_c, k_ϕ and n. The equation, obviously, corresponds to the simpler equation for a plate quoted above :

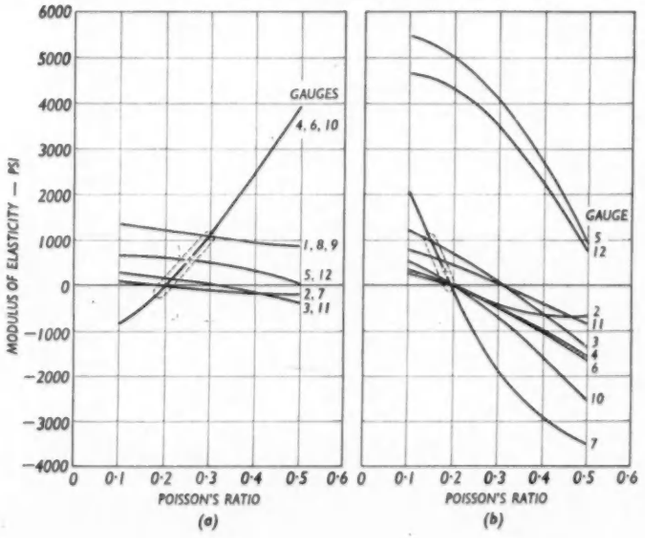
$$z=\left[\frac{W}{(3-n)\,(k_c+bk_\phi)\sqrt{D}}\right]^{\frac{3}{2n+1}}$$

By fitting the wheels with grousers and driving, or braking, them to produce relative displacement between the wheel and the soil, one can measure the tractive effort H and the corresponding slip i. For large wheels and relatively small sinkage one can use the following equation evolved at the Land Locomotion Laboratory :

$$H=(Ac+W\tan\phi)\left[1-\frac{K}{il}\left(1-e^{-\frac{il}{K}}\right)\right]$$

where l is the length of the ground contact area. From this, repeating the traction-slip tests for various loads W, one can obtain the shear-slip soil parameters K, c and ϕ. The test procedure involves gradually applying a braking torque to the test wheel by means of an electro-magnetic friction brake connected to the wheel by a chain drive, and the tractive force is measured by an electric strain gauge torquemeter. Loading of the test wheels is provided by weights acting through a cable and pulley system, as in the sinkage case, and slip, the speed difference between the test wheel and the reference wheel which rolls without slipping, is measured through a differential gear device.

The instrument has been tested by mounting it on the travelling carriage of a soil bin, 40ft long, 5ft wide and 2ft deep, and towing at a constant velocity of approximately 1ft per second, the length of each run being about 30ft. Test data were recorded continuously during each test and slip varied gradually from 0 to 100 per cent for the shear-slip tests, so that each run produced a complete traction-slip curve. Load on each test wheel was varied from 50 lb to 800 lb. The tests were performed in two basic types of soil, namely dry sand and loam, and before each test soil values were measured with a



(*a*) Test in silty clay.
(*b*) Test in plastic clay.

Fig. 3—Correlation of experimental results with theory

§ Love, A. E. H., "The Stress Produced in a Semi-Infinite Solid by Pressure on Part of the Boundary," *Trans. Royal Soc.*, Series A Vol. 228, 1929.

‖ Bekker, M. G., op. cit., page 191.

conventional Bevameter with which the result obtained with the wheel instrument were compared. All the results were analysed statistically and are summarised in the following table. The comparison shows very close agreement for the sinkage soil parameters. Shear soil parameters c and ϕ are slightly higher for the wheel instrument, due to the fact that bulldozing resistance was measured as part of the traction; this could be minimised by driving the test wheel instead of braking it. There is also a significant difference between the values of the shear deformation modulus K, but as the values obtained with the wheel instrument have given better agreement between predictions and actual vehicle test data they are regarded as more acceptable for practical purposes than those obtained with the conventional Bevameter.

Comparison of Test Results obtained from Wheel Tests with the Conventional Bevameter Test Data

1. Soil : Dry Mason Sand

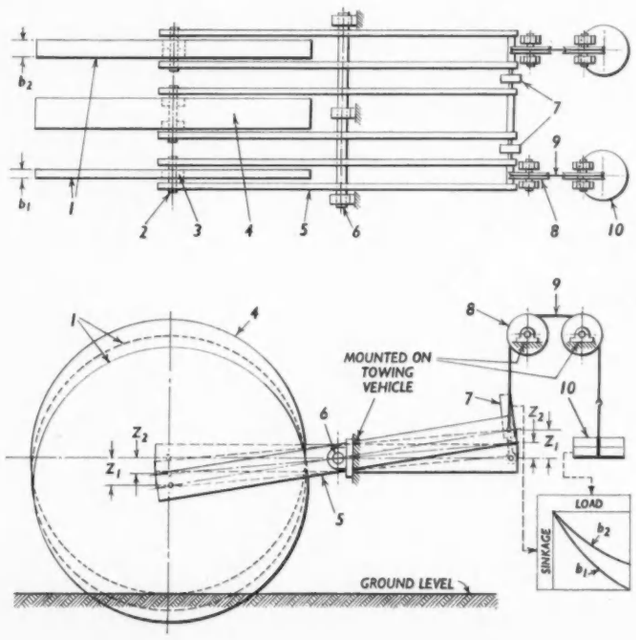
Soil values	Wheel type test device		Conventional Bevameter	
	Mean value	Standard deviation	Mean value	Standard deviation
n	1·1825	0·0554	1·110	0·046
k_c	0·04	0·325	0·112	0·257
k_ϕ	3·58	0·410	3·925	0·504
c	0·2375	0·086	0·150	0·093
ϕ	20·5	2·05	28	1·85
K	1·50		0·70	

2. Soil : Loam (farm soil)

Soil values	Wheel type test device		Conventional Bevameter	
	Mean value	Standard deviation	Mean value	Standard deviation
n	0·680	0·143	0·690	0·079
k_c	2·40	1·24	2·31	1·72
k_ϕ	15·78	1·32	16·85	2·30
c	0·44	0·104	0·25	0·061
ϕ	33·66	1·07	29·7	1·09
K	1·10		0·50	

The design of the wheel instrument has now been turned over to an instrument manufacturer and, as was stated during the discussion of the paper, inquiries may be addressed to the Land Locomotion Laboratory, U.S. Army Ordnance Tank-Automotive Command, Center Line, Detroit.

Laboratory apparatus similar in principle to the conventional Bevameter but using test plates driven by electric motors through reduction gearing and having proving rings for load measurement, as well as a shear plate instead of the shear ring, were described in "Effects of Remoulding on Soil Values Related to Vehicle Mobility," by L. J. Goodman and C. N. Lee, of Syracuse University, New York. The apparatus has been used for preliminary studies of samples of soft to medium lacustrine clays remoulded by passing a rigid wheel over the clay, which have shown that the dispersion of k_c and k_ϕ values is greatly reduced by remoulding and that their mean values are also reduced; on the other hand, the value of n increases.



1—Test wheels.
2 and 3—Test wheel axle and bearing.
4—Reference wheel.
5—Test wheel arm.
6—Test wheel arm shaft.
7—Linear potentiometer for measuring sinkage.
8—Pulley of loading system.
9—Cable of loading system.
10—Loading weight.

Fig. 4—Schematic drawing of a wheel type test device for determining load-sinkage relations in soil

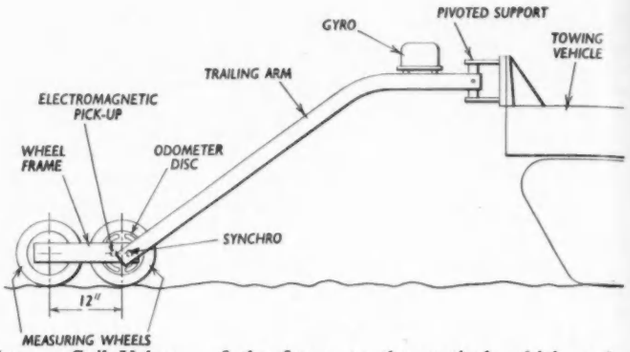


Fig. 5—Terrain measuring assembly

Other types of instruments, for more detailed investigations of stresses in the soil, were described in "Instrumentation for Land Locomotion Studies," by W. F. Buchele, of Michigan State University. In particular, the author briefly described a diaphragm transducer with one strain gauge glued to the diaphragm and small enough to be placed in the lugs of an agricultural tractor tyre to measure the tyre-soil interface pressures.

Another aspect of land locomotion research is the measurement of terrain geometry, and a device developed for this purpose was described by I. J. Sattinger and S. Sternik, of the University of Michigan. The device, shown diagramatically in Fig. 5, consists essentially of a two-wheel assembly which is towed across the ground by a suitable vehicle to obtain a profile of the terrain. The two 11in diameter wheels are mounted in tandem on a frame with a 12in wheelbase, the frame being pivoted on the end of a long trailing arm which connects it to the towing vehicle and which can rotate in yaw and pitch. The travel of the front wheel is recorded by means of a odometer consisting of an electro-magnetic pick-up and a slotted disc attached to the wheel; the pitch angle of the frame to the vertical, which varies as the two wheels pass over ground irregularities, is measured by means of a synchro system. This consists of one synchro attached to the front wheel, so that it indicates the angle between the wheel frame and the trailing arm, and a second synchro attached to the pitch gimbal of a vertical gyro mounted on the trailing arm so that it measures the angle between the arm and the vertical spin axis of the gyro. The stator windings of the two synchro windings are electrically connected in such a manner that the voltage of the output rotor winding is proportional to the sine of the angle between the longitudinal axis of the wheel frame and the vertical. This output signal consists of a 400 c/s carrier voltage whose amplitude and phase correspond to the sine of the angle.

The odometer and synchro system data are recorded on two channels of a magnetic tape recorder and subsequently processed to obtain a record of the terrain profile in terms of x and y co-ordinates. On the basis of preliminary test results, the device is said to be capable of obtaining terrain profiles with an error which does not exceed 4in in a distance of 100ft. The possibility of errors arising from the bouncing of the measuring wheels is claimed to be held within acceptable limits by restricting the speed of the towing vehicle, up to 5ft per second being said to be possible.

A laboratory method of measuring forces and couples acting on a wheel was given by J. R. Phillips in a "Brief Description of the Six - Component Oblique - Rolling - Wheel Machine Recently Constructed and Tested at the University of Western Australia." The paper did not, unfortunately, contain a diagram of the machine, but it consists, essentially, of a wheel rolling on a conveyor belt and mounted in a framework supported by two flexible steel cables which extend obliquely from adjustable fixings in the ceiling of the laboratory to other adjustable fixings on either side of the frame. The pneumatic tyred wheel can be set at different camber and slip angles and may be driven or braked by an electric motor, the drive assembly incorporating a torquemeter as well as reduction gearing. The weight and the mass centre of the frame can be altered by means of a movable basket with lead weights; knowing the weight and mass centre and the tensions in the cables, which incorporate proving rings, as well as the location of the cable ends, three external forces acting on the frame and wheel assembly are determined in magnitude and direction. The remaining force, that is the reaction between the wheel and conveyor belt surface, and the associated couple can then be obtained by somewhat laborious three dimensional vector addition. The machine does, however, provide an interesting apparatus which is said to accommodate itself to wheel or surface irregularities better than more rigid machines.

(To be continued.)

James Starley and the Establishment of the Bicycle Industry

By A. K. BRUCE, M.I.Mech.E., Mem.A.S.M.E.

IT is just a century since James Starley, then in his thirtieth year, migrated from London to Coventry and joined the Coventry Sewing Machine Company as foreman. At the time (1861) of Starley's arrival at Coventry the bicycle, destined to prove of such great industrial importance to the city, had not passed beyond the stage reached, twenty-two years earlier, in the manually propelled two-wheeled hobby horse created by Kirkpatrick Macmillan and now preserved at the Science Museum, South Kensington. When Starley settled in Coventry during 1861, Otto was working in Cologne on an experimental gas engine and would shortly, along with Langen, turn his attention to the free-piston engine. Daimler spent some months of 1861 working in England, visiting among other places the Manchester establishment of Joseph Whitworth and Co. Daimler's motor-cycle patent was not granted until 1885 and it was in 1888 that Dunlop applied for his pneumatic tyre patent.

Before dealing with the part played by James Starley in the promotion of the cycle industry, some account should be given of his early personal history. He was born on April 21, 1831, at Albourne, a Sussex village about eight miles from Brighton. His father (Daniel Starley) was a farmer and the old timber-framed house in which the future inventor was born is still to be seen, indeed, members of the Starley family continue to reside in the village as they have done since the eighteenth century. The young James Starley left school when about eleven years of age and then commenced to work on his father's farm. Though he never received the benefit of anything resembling technical education, Starley was noted from boyhood onward for his inventive talent. Even as a farm lad he is recorded as having produced a device for suppressing the rats which were a serious nuisance in and about the farm. This contrivance—it proved effective—was improvised from a steel umbrella rib ground to a sharp point and operated by the release of the strained branch of a willow. Not for long did Starley remain on his father's farm, since while still a youth he left Albourne and walked to London where he found work as a gardener. One of his earliest employments was as under-gardener at the Lewisham residence of John Penn, the famous marine engineer, where he soon gave an example of his ingenuity. It appears that Mr. Penn was seeking some means whereby it would be possible for his ducks to pass from the garden into the Ravensbourne River without permitting the rats to pass in the reverse direction. Starley devised an arrangement—he called it a " duck balance "—the efficacy of which was recognised in a monetary award made to him by Mr. Penn.

We are not surprised to read that while working as a gardener in Lewisham, Starley's spare time was occupied in inventive activity. Some of the devices which he then arrived at appear to have possessed considerable merit. Among others, we hear of a self-rocking bassinet, an automatically operated window and an adjustable candlestick. Having also spent much spare time in the workshop of a neighbour who was a jobbing clockmaker, Starley had acquired a degree of proficiency enabling him to undertake the repair of clocks and watches. He further increased his income by repairing umbrellas, sewing machines and musical instruments. It was indeed the knowledge Starley then acquired in connection with sewing machines which is said to have induced him to abandon gardening and devote himself to mechanism. He therefore entered the employment of a firm of sewing machine makers in High Holborn.

It was while working in High Holborn that Starley made his first improvement in the sewing machine, this relating to the double chain stitch. He remained as a working mechanic with the sewing machine makers until his migration to Coventry in 1861, where he found employment as foreman

This typically Victorian monument to James Starley was erected in Coventry in 1884

in a sewing machine factory. While thus employed Starley's ingenuity effected notable improvements in the machines manufactured by the Coventry Sewing Machine Company, and when, in 1868, the business became known as the Coventry Machinist's Company, Starley continued in charge of design. It was during 1868 that " great consternation " was said to have been caused among the citizens of Coventry by the appearance of Rowley B. Turner of the Coventry Machinist's Company riding a weird-looking contrivance from the railway station to the works at Cheylesmore. This proved to be a Michaux " Velocipede " which Mr. Turner had brought over from Paris, the Coventry Machinists' Company having undertaken, in or about 1868, the manufacture of the Michaux bicycle. Becoming quickly known in England as " boneshakers," they were the first bicycles produced on a commercial scale. At the outset and as delivered to the Coventry Machinists' Company, the Michaux " boneshaker " was " an extremely crude affair with wheels of hickory wood built up with felloes of ordinary shape covered with an iron tyre." It embodied, however, the principle of the crank action (the cranks and pedals driving the front wheel) and was already becoming popular in France. As in the case of Kirkpatrick Macmillan's bicycle of 1839, the construction of the Michaux machine was such that it could be propelled and guided by the rider without his having to touch the ground with his feet, while enabling him to travel at a speed more than double that reached by a pedestrian.

Starley must have been among the first who, on its arrival in Coventry, made a critical examination of the Michaux bicycle. In the state of development which it had then reached, riding this machine entailed much effort as well as a great deal of practice, and Starley applied himself from the outset to devising means whereby it could be improved from the points of view both of the manufacturer and the user. There is a record in 1869 of his having joined William Hillman in a journey by bicycle from Coventry to London, a journey accomplished in one day. This was doubtless the first occasion on which it had ever been made on a manually operated road machine. When we look at the example of the Michaux bicycle exhibited at the Science Museum and remember also the nature of the road surfaces over which it was driven, it does not surprise us to read how the journey " severely punished the riders and compelled them to lie idle for a day or two." The fact of Starley himself being one of the riders was undoubtedly the direct cause of a great many of the improvements which were made in the machine. In this connection it is related how Starley " would get up in the middle of the night if an idea struck him and pencil out on a piece of paper, or cut out of a piece of cardboard, the idea or plan so that it might not slip away from his mind before morning." One of these improvements—it is believed to have been the first—was the addition to the bicycle of the step for facilitating mounting. This was " first placed on the bicycle which Starley himself rode simply for his personal convenience." Being a man of portly dimensions weighing between 14 st and 15 st, the original mode of mounting (by vaulting from the ground into the saddle) was neither trouble-free nor without some risk. The addition of the step—it was never patented—" led to other and greater improvements which made the bicycle a more and more practicable machine." To be mentioned among them is the tangent wheel of 1874. Apart from those contributions which, made by Starley, assisted so materially in the development of the safety bicycle, there can be no doubt as to the credit due to him for having played the major part in the introduction of the tricycle. The one-time popularity of this machine may be said to date from the introduction in 1876 of Starley's " Coventry Tricycle." Anyone scrutinising the example preserved at the Science Museum will have no difficulty in appreciating some of the features distinguishing this particular machine from those immediately preceding it. The differential " balance "

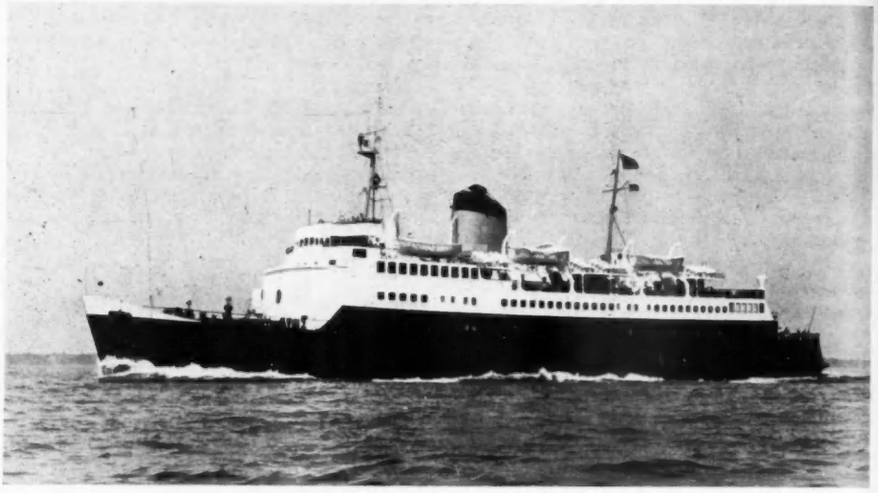
gear used on his tricycle and included in one of Starley's patents was known before his time, though it is certain that Starley was not only unaware of any anticipation but that on becoming alive to its existence he disclaimed the device. The "Coventry Tricycle" was made by Messrs. Haynes and Jefferies and while fitted at the outset with lever gearing was soon equipped with chain drive, an improvement which enhanced its popularity.

Starley's activities as an inventor made themselves felt at a crucial time in the industrial history of Coventry. Not only was the watch trade suffering from great depression, but the ribbon trade had become paralysed by the operation of the French Treaty. These were, at the period in question, the industries on which the prosperity of the city had been largely dependent. There was no cycle industry, nor indeed did the word "bicycle" become current until about 1868. The establishment of the cycle industry and of those industries ancillary thereto was a momentous event in the history of Coventry and the fact that James Starley became known as the "Father of the Bicycle" is a sufficient indication of the part played by the inauguration of the Coventry Machinists' Company and by the collective efforts of those skilled and imaginative men who were there associated with Starley. In addition to participating in the rescue of Coventry from a trade depression, they may be said to have converted what had been little more than a curiosity into a machine of universal utility. One of his biographers has remarked that "By his many improvements Starley rendered bicycles and tricycles machines capable of general use. . . . To his perseverance and energy Coventry owes its position as the centre of industry for the manufacture of cycles. Starley's ingenuity was as remarkably displayed in inventions which he failed to patent. These included the chain-wheels of the tricycle."

James Starley died in Coventry on June 17, 1881, being then in his fifty-first year. He is commemorated in the city of his adoption by a monument, which, erected on Greyfriars Green, was unveiled on November 8, 1884. At the civic banquet which followed the unveiling the speaker who proposed the toast of "The Memory of James Starley," remarked on the fact that Starley "did not reap in his life such reward for his great work as he might have done . . . but his sole object seemed to be to perfect any idea upon which he might be engaged. He never seemed to be quite satisfied with anything which he had invented himself, so he kept going on from perfection to perfection and while he was doing his best to benefit his fellow creatures and securing for himself a lasting fame, the riches of this world which he might have accummulated were passed by almost unheeded and uncared for." Not to be forgotten among other tributes is the respect with which Starley was regarded by those who worked under his guidance and direction. In the first volume of a set of books presented to him on March 21, 1868, by workmen at the Coventry Sewing Machine Company, there is the following inscription :

> "Presented to James Starley by the workmen in the employ of the Coventry Sewing Machine Company as a token of respect for the manly and upright manner in which he has filled the position of foreman."

Confirmation of the esteem in which he was held is found in the fact that the monument on Greyfriars Green was subscribed for by the workmen of Coventry. Significant as this is, Starley possesses a distinction which will outlast any monument erected to his memory. He belongs, as does that Dumfriesshire blacksmith Kirkpatrick Macmillan, to the select company of those men who, without scientific or theoretical training of any kind, have become noted inventors. They and others like them, are artists as well as artisans, "artist" being a title surely applicable to him who, irrespective of his vocation, strives to attain perfection in his work. Writing of the piston aero-engine and having in mind the late Sir Henry Royce (who began life selling newspapers and had worked as a telegraph boy) Sir Harry Ricardo remarks how "in every successful example it will be found that the actual designer of such an engine is neither a great scientist, nor an expert mechanic, but an artist with an artist's temperament and intuitive genius . . . . Such men are rare and in any one country can be counted almost on the fingers of one hand."



Vessel for Sailings to the Channel Islands—S.S. "Sarnia"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

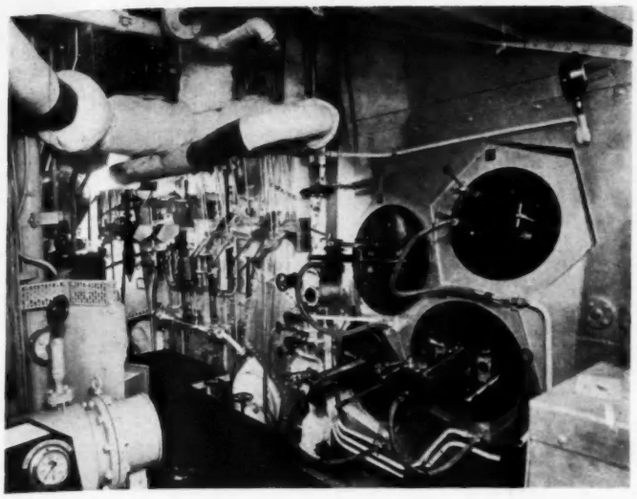
IN a previous article* it was stated that the British Transport Commission intended to concentrate all Channel Islands sailings on Weymouth as the one mainland port, and by this it is hoped that an annual loss of £200,000 will be turned into a profit. For this purpose instead of having to maintain five steamers, three will suffice; "Caesarea," "Sarnia" (above) and the post-war "St. Patrick" (below) which has been extensively refitted as a one-class steamer of the same standard of comfort as the new vessels.

For some considerable time there was keen competition between the steamers of the London and South Western Railway and those of the Great Western Railway, but with the nationalisation of the railways this competition was eliminated, with the result that by using vessels as big as could be accommodated in the Channel Islands ports the number of sailings could be materially reduced.

As will be seen from the illustration, "Sarnia" has a modern look with raked stern, rounded stem, tripod masts, and a single funnel, specially designed to sweep the fumes clear of the vessel in all weathers. She was built by J. Samuel White and Co., Ltd., of Cowes, Isle of Wight, her principal dimensions being : length, overall, 322ft, on waterline, 312ft ; breadth, moulded, 51ft ; depth, moulded to main deck, 18ft 9in ; tonnage, 4174 gross ; s.h.p., 8500 ; corresponding revolutions per minute, 275 ; designed speed, 20 knots. The form of hull was

*THE ENGINEER, December 9, 1960, page 975.

S.S. "St. Patrick"



The boiler-room

The galley

decided after a series of model resistance and self-propulsion tests carried out at the National Physical Laboratory. All exposed weather decks are sheathed with teak. The hull below the main deck (bulkhead deck) is subdivided into watertight compartments by means of eleven watertight bulkheads. A cellular double bottom is fitted throughout except in the way of the fore and aft peaks and aft shaft tunnel. All double bottom tanks are arranged for the carriage of waterballast or fresh-water. Furnace fuel oil, diesel oil and distilled water are carried in deep tanks above double bottom, and fresh-water in wing tanks at the aft end of the engine-room.

For steering there is a balanced rudder aft, and a bow rudder for use when the vessel is being navigated stern first, these being operated by rotary vane type steering gear of A.E.G. manufacture, the power being supplied by hydraulic pumps driven by electric motors. Control from the bridge in each case is electric. Direct current electricity supply at 225V is provided by three main 225kW and one emergency 50kW diesel-driven generators. Two motor alternators supply fluorescent lighting. To minimise rolling Denny-Brown stabilisers have been installed.

Propulsion is by means of two single-casing steam turbines, of Pametrada design (impulse type with ahead and astern elements incorporated on a single rotor shaft), each driving a three-bladed " Novoston " alloy propeller through articulated locked train double reduction gearing.

Steam for the main machinery at a pressure of 350 lb per square inch and a temperature of 650 deg. Fah. is supplied by two Foster Wheeler oil-fired, water-tube boilers fitted with superheaters. The boilers work under an open stokehold forced draught system, air being supplied by turbo-driven fans. Steam for domestic services, bunker heating, &c., and supply to the distiller, the latter providing make-up feed for the main boilers, is supplied by two oil-fired Spanner boilers working at a pressure of 60 lb per square inch.

There is one-class accommodation for 1400 passengers, who are carried on all decks except the navigating bridge deck. Private cabins are available for sixty-two passengers in one and two-berth cabins situated on the lower deck forward and two cabins-de-luxe on the promenade deck. There is seating accommodation for all passengers. The public rooms are on the main, upper, and promenade decks, and there are two twenty-two-berth sleeping lounges on the lower decks.

The captain's day cabin and bedroom are on the navigating bridge deck, deck and engineer officers' cabins, mess room and toilets in the deck house on the boat deck ; while there is accommodation for stewards, catering staff and deck and engine-room ratings on the main deck.

General cargo is carried in the forehold general cargo and motor-cars in forward and after 'tween decks. Steward's and bonded stores are on the lower deck forward and aft. Cold room, preparing room and refrigerating machinery room are also on the lower deck aft.

A Thermotank system of heating and ventilation is provided for all passenger and crew accommodation.

Precautions have been taken against fire hazard in excess of present statutory requirements of the International Convention for safety of life at sea including Grinnell sprinkler system, linings, divisional bulkheads, &c., of incombustible material, and a complete fire detection and alarm system.

Life saving apparatus includes six " Fibreglass " lifeboats with built-in buoyancy, designed and constructed by the shipbuilders. Two of the boats are propelled by diesel engines and four by hand mechanical propelling gear. In addition to the boats forty-five inflatable life rafts are installed on special launching way.

The smooth running and general comfort of this the latest of British Railways' cross-Channel steamships was very noticeable on a demonstration cruise on June 13 between Southampton and Weymouth, and there is every reason to believe that " Sarnia " will have a long and successful career.

Technical Reports

Comparative Tests on Heating School Buildings by Electric Thermal-Storage Block Heaters and Other Methods. (Utilisation Research Report No. 16.) Obtainable gratis from the Press and Information Officer, The Electricity Council, Trafalgar Buildings, 1, Charing Cross, London, S.W.1.—This research report summarises comparative tests on heating school buildings (by electric thermal storage block heaters and other methods) which have been carried out in co-operation with the Ministry of Education, using four pairs of schools. One school from each pair was heated by hot water radiators and the other by block heaters ; temperature and consumption records were obtained for one heating season. It was found that the capital cost of a block-heater installation was comparable to that of a solid-fuel installation, and considerably lower than that of an oil-fired installation. Although the running costs of the electrical installations proved to be 50 to 100 per cent higher than those of the solid-fuel ones, and 30 per cent lower than the oil-fired installation, the total annual cost of electric heating equalled that of solid-fuel and was less than oil-heating. The temperatures maintained at all the schools did not differ significantly, but all systems failed in varying measure to provide the specified temperature (62 deg. Fah.) during a cold spell, and it is recommended that the installed block-heater capacity should be at least 25 per cent greater than the calculated heat loss. The annual consumptions for the electrically-heated schools ranged from 21,000kWh to 31,900kWh per therm (685kWh to 1090kWh per kilowatt) of calculated heat loss. These consumption figures could probably be reduced by improved methods of control, which would prevent overheating in mild weather.

RILEM Symposium, Munich, 1958. RILEM Bulletin No. 9, December, 1960. Paris : The International Union of Testing and Research Laboratories for Materials and Structures (RILEM). General Secretariat, 12, rue Brancion, Paris (15e). Price S.fr. 15.—Publication of the proceedings of the symposium " Influence of Time upon the Strength and Deformation of Concrete," held at Munich in November, 1958, is concluded in RILEM Bulletin No. 9 (New Series). The issue contains the general reports, summaries, results of discussions, and final conclusions. Aspects dealt with in the discussions included the lessening of strength occasionally observed with aluminous cements, climatic effects on the hardening of clay cements, the maturing of test pieces, carbonation and wall effect, and the influence of the shape of the test piece. A matter on which few research results are available is the influence of fatigue, and the same applies to concrete subjected to compound stresses. A proposal concerning a unified terminology in English, French, and German, relating to the deformation of concrete, was adopted in a modified form. The discussion turned to the subject of creep recovery (delayed elasticity), and to the need of standardising in creep research upon certain types of concrete in order to get results which are comparable.

An important problem is that of the relationship between laboratory results and work on the site. Important recommendations were made regarding future research. The physical and chemical causes of the strength and deformation of concrete were discussed at length. Electron microscopy has shown hardened current paste to be of the nature of a rigid gel. Other studies have shed light upon the interaction between binding paste and aggregate, e.g. by investigating aggregates coated with tar. There appears to be a need for further work on the origin of rupture in concrete, and the manner in which it progresses. The interdependence of shrinkage and creep also calls for further study.

District Gamma Radiation Survey Around A.E.R.E., Harwell : Results for 1958 *and* 1959 (A.E.R.E.-M761). By A. Morgan. U.K. Atomic Energy Authority. H.M. Stationery Office. Price 1s. 9d.—The results of a gamma radiation survey carried out in the district surrounding the Atomic Energy Research Establishment, Harwell, during 1958 and 1959 are described. Dose-rate measurements were made at a large number of fixed points within this area using portable ratemeters.

Over this period no variation in dose rate due to deposition of radioactivity originating in the Atomic Energy Research Establishment could be detected ; the variations in gamma dose rate observed were due to the deposition of fission products from nuclear test explosions and maximum levels were reached in May-June, 1959 (μr per hour). Since that period the dose rate has declined due to the reduced rate of deposition of fallout and radioactive decay of fall-out already on the ground.

Soviet Exhibition at Earls Court

No. I

TO-DAY is the opening day of the Soviet Exhibition at Earls Court, London. The Exhibition will open daily until July 29, from 10 a.m. until 10 p.m., Sundays excepted. Like the British Trade Fair held in Moscow in May, it is being held under the joint sponsorship of the Association of British Chambers of Commerce and the Chamber of Commerce of the U.S.S.R. The latter is a Soviet public organisation, the chief aim of which is to foster business contacts with foreign firms and also to extend trade within the Soviet Union. It maintains close relations with all Soviet trading and industrial associations.

The Soviet Exhibition in London aims to show people in this country the growing possibilities of Anglo-Soviet trade. Like the British Trade Fair it is a trade and industrial display. All Soviet foreign trade associations and the Economic Councils have rendered assistance to the Chamber of Commerce in organising the exhibition, in the preparation of which a number of other organisations, notably the U.S.S.R. Academy of Sciences, have played an active part. About 1000 industrial enterprises of the Soviet Union have contributed exhibits. The U.S.S.R. Ministry of Foreign Trade has lent its full support, and one of its top officials is acting as director. The Chamber of Commerce of the U.S.S.R., as a co-sponsor, is covering all expenses connected with the promotion of the exhibition, which is not only the first Soviet Exhibition to be held in London, but is also one of the largest which have been held abroad, exceeding by over 10 per cent the Soviet Pavilion at the Brussels World Fair.

Over and above its display of Soviet production the exhibition aims at conveying something of the progress which is taking place in science and industry, the conditions of life of the Soviet people, and the manner in which they participate in their country's technical advance.

The exhibition covers a total of 225,000 square feet and occupies twenty-two halls, in which some 10,000 exhibits are being presented. Its eight principal sections are : Science, Industry, Transport, Building, Agriculture, Education, Public Health, Consumer Goods, and Culture. An additional introductory section will acquaint visitors with the main trends of Soviet economic development.

A great deal of effort has been devoted by Soviet artists to the design of the exhibition as a whole and to the individual displays ; a number of British firms have also been concerned in the construction work. Over 300 Soviet citizens are working in the exhibition administration and as guides and interpreters. An information bureau in the entrance lobby at Earls Court is in operation to answer inquiries about any of the exhibits. Personnel of the Commercial Group, drawn from the staffs of the U.S.S.R. Trade Delegation in Great Britain and those of the Soviet Foreign Trade Associations, and other experts are available. These officials are being supported in their work by a party of seven, headed by the chief of the First Export Department of the U.S.S.R. Ministry of Foreign Trade. All have the authority to establish contacts, conduct negotiations, and sign contracts with British firms. A special guide is being issued to visitors containing descriptions of the various sections, and information about the various Soviet Foreign Trade Associations.

Fig. 2—Turbo and electric oil drills. Among the first four drills from the top is the 7·5in turbo drill which is being shown at the Exhibition. The fifth and sixth from the top are electric drills

Fig. 1—Icebreaker "Lenin," the world's first nuclear-powered icebreaker and flagship of the Soviet Arctic Fleet. A sectioned scale model of the ship is being shown, as well as films of her voyages

Events include two fashion parades for 1½ hours and two hours daily, and three on Saturdays. These are being held in the Fashion Theatre on the first floor at Earls Court. Between fashion shows, the theatre is screening a number of Soviet travel and popular science films. In addition, over 100 technical films are being shown on more than eight screens on the stands, including two multi-screens for the simultaneous display of several films.

In the following paragraphs we shall briefly outline some of the background of the different parts of the exhibition, and follow these up with a description of some of the exhibits themselves.

The displays in the Entrance Halls are designed to give visitors a general outline of technical and economic development in the various spheres of the Soviet economy, and to provide information concerning scientific and cultural activities in the Soviet Union.

Economic life in the Soviet Union is based on plans worked out by a governmental committee (GOSPLAN) which was set up in 1921 and first carried out its task on an annual basis, later (from 1928-42) on a five-year basis. The war interrupted this task which was resumed in 1946. In 1959, the current seven-

year plan was adopted which aims at increasing production by 80 per cent, so as to exceed that of any capitalist country. So far the plan is stated to be ahead of schedule, total industrial output growing by 22·1 per cent in 1958 and 1960, compared with the planned figure of 17 per cent. Longer-range planning is the task of the State Scientific Economic Council which is now engaged on a general plan for the next twenty years.

One of the major aspects of all Soviet plans has been the high degree of priority given to the basic and heavy industries. At present capital investment is stated to be at the rate of about 25 per cent of the national income, while 75 per cent goes to consumption.

The State budget this year of 79,000 million roubles (£31,600 million) is covered to the extent of 91·2 per cent by profits tax on State enterprises, collective farms and co-operatives, direct taxation covering only about 7 per cent of revenue (income tax is in fact to be eliminated by 1965). Of the total expenditure, financing the national economy accounts for 33,900 million roubles or 43 per cent, on top of which individual enterprises will invest 22,500 million roubles out of retained profits and reserves. Military expenditure is being steadily reduced and this year amounts to less than 12 per cent of the total outgoings. Over one-third goes to the social services (education, science, health, and social insurance). The budget shows a surplus of 1400 million roubles (1960= 3600 million roubles).

The earliest Soviet economic plan was that of 1920 for the electrification of the country (GOELRO) which laid the basis for the subsequent development of the generation and transmission of electric power and its application in industry and transport. This year, the output of electricity, it is estimated, will be 327,000 million kWh, equal to the combined production of Great Britain, France, Japan and Italy. Because expansion is quicker and cheaper this way, thermal generation is now being favoured at the expense of hydro-electric schemes, and thermal power stations with an installed peak capacity of 2400MW each are now under construction. As regards hydro-electric development, the Soviet Union now has in service the largest stations in the world in the shape of the "Lenin" and Stalingrad power stations on the Volga, with installed capacities of 2300MW and 2415MW completed in 1957 and 1960, respectively. These will soon be surpassed by Bratsk on the Angara River in Siberia, with 4750MW, of which the first four units will come into operation by the end of this year.

Nuclear developments are illustrated by the world's first atomic power station of 5MW capacity which came into operation seven years ago, and by the nuclear icebreaker "Lenin," of which a model is being shown as well as films of her voyages (Fig. 1).

A major sector of power production is oil and natural gas, and a substantial part of the exhibition is devoted to this exploitation in the Soviet Union. By 1965 it is envisaged to produce some 230 million to 260 million tons of oil and 150,000 million cubic metres of natural gas, and to satisfy from these sources over half the country's fuel requirements, instead of one-third as at present. To-day the world's third oil-producing country, the Soviet Union has also made important contributions to the technology of the industry, pioneering the turbo-drill and electric drill which apply the power at the bottom of the borehole and thus relieve the rig from excessive torque. Fig. 2 depicts some designs of turbo and electric drills which are now being used to carry out about 10 per cent of all drilling operations.

Given a continuous rate of expansion of 18,000,000 to 19,000,000 tons per annum achieved during the past two years of the current seven-year plan, the present level of output in the U.S.A. would be exceeded by 1968.

Large new gas fields discovered during the last few years and older fields aggregate proven reserves of 2,000,000 million cubic metres. By the early 1970s, natural gas is likely to increase its share in the country's fuel balance from 10 to 25 per cent or more. The major producing areas are in the Northern Caucasus, the Ukraine, Azerbaijan, and the regions of Saratov and Kuibyshev on the Volga, and other fields are being developed in Uzbekistan and Turkmenistan. Gas trunk pipelines, excluding distributive branch systems, total 13,250 miles and supply such major cities as Moscow, Leningrad, Kiev, Kharkov, and many others. The mileage is being rapidly extended, and it is planned to treble the network in the course of the present seven-year plan and the extend it throughout all the fifteen constituent republics of the Soviet Union.

(*To be continued*)

OBITUARY

SIR WILLIAM CURRIE

We regret to record the death of Sir William Currie, G.B.E., which occurred on July 3. William Crawford Currie was born in Calcutta on May 4, 1884, the son of William Currie, who served in the Indian office of the British India Steam Navigation Company for many years. This early introduction to shipping was to have a profound effect on his later life, and, as is well known, he became one of the best-known figures in the shipping world, his many directorships including the position of chairman of his father's old firm.

At an early age Currie came to England, and was educated at Glasgow Academy, Fettes School and Cambridge University. After leaving Cambridge in 1906 he joined David Strathie, a firm of chartered accountants in Glasgow, and qualified as an accountant four years later. He then returned to India and became an assistant in Mackinnan Mackenzie and Co., managing agents of the British India Steam Navigation Company, becoming a partner in 1918 and senior managing partner in 1922. In India Currie took an active part in public life, being elected to the Bengal Legislative Council, and serving as Sheriff of Calcutta in 1921–22. Before he left India in 1925 he was appointed Member of the Council of State for India, and received a knighthood.

Sir William returned to England in 1926, and became a partner in Gray, Dawes and Co., the London agents of the British India Steam Navigation Company. In the following year he became a member of the Imperial Shipping Committee, and in 1929 he was elected President of the Chamber of Shipping. Following the death of Lord Inchcape in 1932, Sir William became a director of the Peninsular and Oriental Steam Navigation Company, advancing later to the position of managing director and, in 1938, chairman.

The P. & O. suffered very severe tonnage losses during the war, and it was under the leadership of Sir William that the line and its subsidiaries rebuilt its fleet to become the world's largest shipping company. Sir William was President of the Institute of Marine Engineers in 1945–46, and Prime Warden of the Worshipful Company of Shipwrights in 1949. He was created G.B.E. in 1947 and appointed a Commander of the Legion of Honour of France in 1953. Sir William was not only a director of shipping companies, being on the boards of banking and insurance concerns as well. In public life he became High Sheriff of Buckinghamshire in 1947, and served as a member of the executive committee of the British Red Cross Society.

MR. BURKEWOOD WELBOURN, M.I.E.E.

Mr. Burkewood Welbourn, who died on July 1, at the age of eighty-five, was one of the pioneers of the electrical cable industry and was, for much of his working life, concerned with the installation of power cables in all parts of the world.

On leaving Framlingham College at the age of seventeen he went to study electrical engineering under John Hopkinson, at King's College, London University. Having graduated, he stayed at King's for a time as a demonstrator, and was then appointed works manager of the Electrochemical Company at St. Helens. In 1900 he took the post of contracts manager of the British Insulated Wire Company of Prescot, one of the parent firms of the present B.I.C.C. group: thus he became responsible for the installation of his company's cables throughout the world. His work involved extensive travels, including a trip to Russia where, in 1910, he was instrumental in setting up a company to make cables under licence from British Insulated. In 1927 he was appointed chief engineer of B.I., succeeding Mr. W. H. Nisbett who became managing director of the company.

Mr. Welbourn was for many years extremely active in the affairs of the Institution of Electrical Engineers. He was elected an Associate in 1897 and transferred to Associate Membership in 1902 and to full Membership in 1907. From 1915 to 1916 he was chairman of what was then the Manchester Local Section. He was the first chairman of the Mersey and North Wales Centre of the I.E.E. in 1922–23 and again in 1933–34. He became a Member of Council of the Institution in 1919 and served as vice-president from 1929 to 1932. The author of many I.E.E. papers, he was awarded the Institution's Paris premium in 1914.

DR. LEE DE FOREST

We regret to record the death in Hollywood on June 30, at the age of eighty-seven, of Dr. Lee de Forest, a pioneer of the radio valve. His invention of the "audion" three-electrode valve, or triode, came in 1906, and was made independently of similar work by Robert von Lieben in Vienna. De Forest was associated with early broadcasting activities in the United States, and between 1919 and 1926 was engaged on development of a system for talking pictures. His business ventures included the De Forest Radio Telephone and Telegraph Company, and the De Forest Phonofilm Corporation. He held some 300 patents in the United States and other countries, and was a founder, Fellow and past president of the Institute of Radio Engineers.

LETTERS AND LITERATURE

Letters to the Editor

WIRE ROPE ROOF TRUSS

SIR,—Page 1032 of your issue dated June 23, is devoted to describing a wire rope roof truss shown at the International Construction Equipment Exhibition and which British Ropes Limited is said to be "introducing into this country, ... the system being known as the Jawerth system, after its originator who is Swedish." I do not know when this system was originated in Sweden. I do know, however, that a 1000ft roof span on this identical principle was designed in England no less than thirty-three years ago and that if any notice had been taken of the ideas of a very young man this system could have been designated British and might conceivably have borne my name.

Enclosed is a photograph of the general perspective drawing (reproduced herewith) which accompanied the plans I submitted as a finalist in the R.I.B.A. Competition in 1928 for "A Design for an Aerodrome on Mitcham Common to fulfil the requirements of Civil Aviation fifteen years hence." The original drawings were exhibited at the R.I.B.A. in London with those of the other finalists. The great roof was supported on internally braced steel towers at each truss, with panel walls between. Trimming the anchor ropes into "arches" having common anchor blocks is a structural and architectural feature that may yet be "originated" by someone, somewhere! It will be seen also that the hangars flanking the field (right and left distance) are similarly roofed, the rope trusses being "in series," as it were, with anchorages only at the ends of the rows; almost identically, in fact, as in your photograph of the buildings at Le Bourget—ironically enough a great aerodrome!

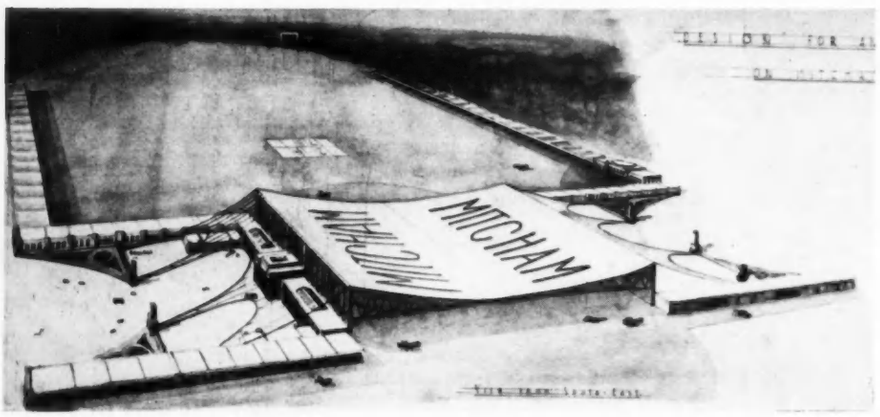
At Le Bourget the roof coverings appear to be slung below the lower cables of the trusses, leaving all the rope-work exposed above. I mounted the covering above the upper cables, a measure which improved and simplified construction by avoiding fixing points penetrating the covering, protected the whole truss from the elements and also enabled maintenance to be carried out in all weathers. Rain water was led from the central valley to the side walls by ducts attached to the lower cables. To me at the time the idea was an original concept, the only precedent of any sort to my knowledge being the velarium over the Colosseum in ancient Rome, though undoubtedly I was influenced by suspension bridge designs.

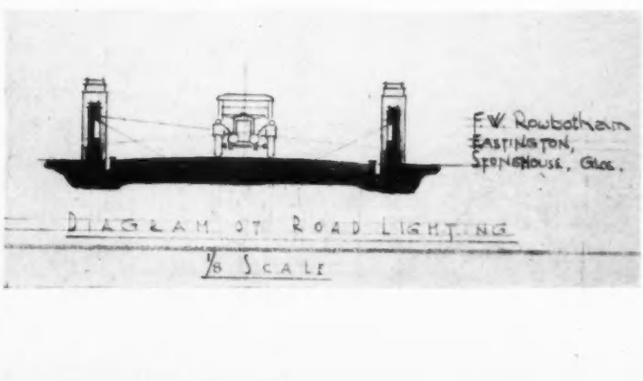
Another original feature incorporated in the general design of the airport was the lighting of the approach roads, which were flood-lit from below the eye-level of drivers, as shown on the second enclosed reproduction. This method avoided dazzle to drivers and eliminated confusion to aircraft pilots. Diffused light would be reflected from the normal road surface. I believe some such idea is now being mooted!

But what chance had a nineteen-year-old provincial student thirty-three years ago?

F. W. ROWBOTHAM

Stonehouse,
Gloucestershire,
June 27, 1961.





(Above)—Wire rope roof truss

(Left)—System of lighting aerodrome access roads

"PROBLEM OF NOTICING THE PROBLEM"

SIR,—The interesting—I would say entertaining—feature in the current issue of your journal is only half the story, as is shown by the experience of a friend of mine who recognised—and solved—a problem which has been under the very noses of countless engineers for more than half a century. My friend, who never had any connection with the engineering industry, was unversed in centre-lathe operations and so, when he embarked on screw-cutting, quickly recognised the difficulties. Result: a mechanism (first produced as an attachment and now to be incorporated in Colchester, Willson, Mitchell, and other lathes) which permits screw-cutting, internal or external and tight up to a shoulder, at any speed given by the lathe concerned.

The irony of the situation thus far has not escaped the more open-minded engineers who know the history of this invention by a complete novice in a world of experts, but the sequel is, to me, quite fantastic. Early literature issued on the device modestly claimed screw-cutting speeds of 1000 r.p.m., with the result, in a surprisingly large number of cases, that it was utterly discounted on the grounds that "no such animal" could possibly exist, yet in fact the device has been operated satisfactorily at 2500 r.p.m. (on a Smart and Brown tool-room lathe) compared with the normal, say, 50 r.p.m. This applied to such an extent that the attachment licensees became convinced they must modify its claims to make it "believable." This they now do by using the word "revolutionary" in the hope that it may mean all things to all men!

A. R. JENKINS

London, W.14,
June 28, 1961.

Book Reviews

Thermoelectric Materials and Devices. Edited by IRVING B. CADOFF and EDWARD MILLER. Reinhold Publishing Corporation, New York; Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 78s.

THE development of semiconductor technology during the past two decades has made available a large number of new thermoelectric materials, some of which look economically promising for power conversion or refrigeration. With the realisation that reasonable efficiencies (10–20 per cent) might be achieved with semiconductor thermoelements, interest, both scientific and technological, has grown tremendously. Recognising the need for presenting the subject in its many facets to engineers and scientists interested in entering the field, the Department of Metallurgical Engineering and the Office of Special Services to Business and Industry at New York University sponsored a one week short course in thermoelectric materials and devices in June, 1959, and again in June, 1960. The present volume is compiled from the principal

lectures in that course, the editors themselves being two of the participating lecturers.

The first section is devoted to the theory of thermoelectric processes and circuits, and is followed by a general evaluation of thermoelectric materials. Several ensuing chapters discuss in more detail the materials currently being used and those being considered for future use. The final section of the book expounds the principles of device design and describes some experimental and prototype units which have been built and evaluated. Since the same thermoelectric figure of merit applies equally to power conversion and refrigeration the two types are treated in an integrated manner. A brief chapter on thermionic conversion has been included in order that the so-called " plasma thermocouple " may be compared with solid state devices.

The selection of material and level of treatment for a short course of this kind, with its heterogeneous membership, is always a difficult problem ; and the problem was not made any easier in the present case by the fact that the score or so of lecturers were drawn from a wide range of institutions. In these difficult circumstances the editors, it must be admitted, have produced a very creditable symposium ; the material has been wisely chosen and the standard of exposition is generally satisfactory and occasionally brilliant. It is particularly gratifying that the editors have not fought shy of including a section (page 8) on the thermodynamics of irreversible processes, and this excellent introduction to an admittedly difficult subject should give encouragement to engineers who find de Groot's definitive work heavy going. The phenomenological theory of liquids introduced on page 187 is a striking exposition of the use of qualitative arguments in conjunction with limited data to estimate physical properties in unknown regions of temperature, pressure, &c. For those concerned with the design and construction of practical thermoelectric devices the numerous data tables should prove invaluable ; particular mention may be made of the tables of refractories in Chapter 11, and the nomographs for Peltier cooling calculations in Chapter 17.

The book does have its shortcomings, however. The editors freely admit that a certain amount of repetition is inevitable in a collection of this kind, but to claim, as they do in their preface, that " such repetition will help integrate the separate chapters " smacks of making a virtue out of necessity. Perhaps the potential space saving (10 per cent?) was not considered worth the editorial labour of eliminating repetitions ; nevertheless one feels that the space saved in this way could have been profitably used elsewhere. Thus, the band theory of semiconductors is summarised twice (pages 75 and 85) while the bond theory receives no mention, although this promises more success than the band theory in explaining the properties of some of the newer semiconducting materials. Again, it is somewhat irritating to encounter repetitions of the definitions of efficiency (pages 20 and 34) and mobility (pages 79 and 85) within a few pages, while more recondite terms such as phonon, many-valley model, extrinsic and intrinsic semiconductors are introduced without definition, so that the uninitiated must guess their meaning from the context. (By contrast—and this illustrates the variability of the treatment—the now-familiar terms fission and isotope *are* defined in the chapter on nuclear heat conversion.)

Typographical errors are relatively few but there are some grammatical lapses, the following example of which is taken from page 39 : " . . . the velocity of the electrons proceeding from the hotter end are greater than those passing through the given cross section from the colder end of the conductor." Really! The curious phrase " infinitely small " occurs in a number of places where I believe British writers would invariably use infinitesimal ; perhaps, however, this is just cisatlantic prejudice against established transatlantic practice. In spite of these minor criticisms the book as a whole deserves high praise, and there is little doubt that it will be found to justify the publishers' claims in the following paragraph which is quoted from the dust wrapper :

" This book will be of special value to metallurgists, electrical and electronics engineers and physicists who are entering the field of thermo-electricity for the first time. To the scientist already engaged in thermoelectric research, the book offers an excellent guide to areas where more work is needed and where further developments are likely to occur."

Prestressed Concrete Simply Explained. By H. KAYLOR. Contractor's Record, Ltd., Lennox House, Norfolk Street, Strand, London, W.C.2. Price 28s.

IN this very simple small book of 150 pages, Mr. Kaylor sets out all the knowledge on prestressed concrete which the interested, but not specially concerned person would want to know. It describes in simple language the whys and wherefores of the subject, the operations of carrying it out, works out in detail several simple examples and finally gives examples of structures built in this medium. A large part of the design portion might be described as a hurried commentary on the Code of Practice 115, from which it quotes at length. Mr. Kaylor has an easy style which makes it a very readable book. It should appeal (though the price appears high for so small a book) to architects and students who wish to have a reasonably thorough grounding in the subject, but who have only a passing interest in it.

The Calculus of Extension. By H. G. FORDER. Chelsea Publishing Company, 50, East Fordham Road, New York 68, N.Y. Price 4·95 dollars.

THIS book is a reprint of a work first published in 1940, after some delay, and based on notes compiled by the late Professor R. W. Genese many years before. It thus repeats in miniature the broad history of Grassmann's ideas and methods. Grassmann was a highly original thinker who suffered from two disabilities : one, which was unavoidable, was the fact that he had Hamilton for contemporary ; the other was a natural obscurity of style. For both reasons, in the Anglo-Saxon countries at least, Hamilton's theory of quaternions took the stage and kept it for a long time. But on the Continent Grassmann has always had considerable influence and in our own day he has triumphed everywhere.

Grassmann's main idea in the calculus of extension consists of a bold generalisation of the methods of classical analytical geometry. Here the basic idea, as expounded by Descartes, is to represent a point by a set of co-ordinates and to develop all the subsequent theory by means of equations. In the nineteenth century it had already occurred to a few geometers that entities other than the point could be taken as fundamental. But the great step forward is due to Grassmann. For example, in a problem concerning points and circles, we upset the balance by using co-ordinates which favour the one or the other ; far better—in theory at least—to introduce symbols for a point and also for a circle, and to set up an algebra from which geometrical properties can be inferred. This is what Grassmann did, and so he is one of the pioneers of modern algebra. Incidentally, during his work he was led quite naturally to formulate a geometry of n dimensions.

In the present generation Grassmann's algebra has found important applications to algebraic and differential geometry and also to topology. Forder's book furnishes many interesting illustrations of Grassmann's methods, besides giving a good idea of the general theory.

Books Received

Packaging Directory 1961. The Tudor Press, Ltd., 75, Carter Lane, London, E.C.4. Price 21s.

Lehrbrief für Kaltetechnik, 21-25. Verlag C. F. Müller, Karlsruhe, W. Germany. Price DM. 7.70.

Guide to the Coalfields, 1961. *The Colliery Guardian*, 30-31, Furnical Street, Holborn, London, E.C.4. Price 20s.

Long-Range Ballistic Missiles. By Eric Burgess. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 35s.

Unified Calculus and Analytic Geometry. By Earl D. Rainville. The Macmillan Company, New York 10, N.Y. Price 45s. 6d.

Impact Testing of Materials. By Wilhelm Späth. Thames and Hudson Ltd., 30, Bloomsbury Street, London, W.C.1. Price 25s.

A Concise Polish-English Dictionary of Mechanical Engineering. Panstwowe Wydawnictwa Techniczne, Warsaw, Poland. Price zt. 46.

Welding Engineer's Handbook. By J. A. Oates. George Newnes Limited, Tower House, Southampton Street, London, W.C.2. Price 21s.

The Encyclopedia of Microscopy. Edited by George L. Clark. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 200s.

Rare Metals Handbook. Second Edition. Edited by Clifford A. Hampel. Chapman & Hall, 37, Essex Street, London, W.C.2. Price 160s.

Introduction to Engineering Mechanics. By John V. Huddleston. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 74s.

Basic Concepts in Modern Mathematics. By John E. Hafstrom. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 51s.

Adaptive Control Processes : A Guided Tour. By Richard Bellman. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 42s.

Introductory Soil Mechanics and Foundations. Second Edition. By George B. Sowers and George F. Sowers. The Macmillan Company, New York 10, N.Y. Price 56s.

Advances in Electron Tube Techniques : Proceedings of the Fifth U.S. National Conference. Edited by David Slater. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 100s.

Freilaufkupplungen, Berechnung und Konstruktion. By Karl Stölzle and Sigwalt Hart. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, W. Germany. Price DM. 31.50.

Werkstopffphüfung Mit Ultraschall. By Josef Krautkrämer and Herbert Krautkrämer. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, West Berlin. Price DM 64.50.

Personen-und Güterbahnhöfe. By Otto Blum. Second Edition, Revised by Kurt Leibbrand. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, W. Germany. Price DM 33.

Algebra with Applications to Business and Economics. By Paul H. Duas and William M. Whyburn. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 51s.

Alternating-Current Machines. Second Edition. By Michael Liwschitz-Garik and Clyde C. Whipple. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 112s. 6d.

Definitions and Formulae for Students: Modern Physics. Fourth Edition. By L. R. B. Elton and Daphne F. Jackson. Sir Isaac Pitman and Sons, Ltd., 39-41, Parker Street, Kingsway, London, W.C.2. Price 2s.

Illustrated Terminology of Mobile Cranes. Glossary in six languages (German, English, Spanish, French, Italian, Swedish). Published by Section V (Mobile Cranes) of the Fédération Européenne de la Manutention. Paris Fédération Européenne de la Manutention, 10, Avenue Hoche, Paris (8e). Obtainable from The Secretary, The Association of Crane Makers, Sardinia House, 52, Lincoln's Inn Fields, London, W.C.2. Price 12s. 6d.

MAINLY METALLURGY

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

The British Non-Ferrous Metals Research Association

THE Annual Report of the British Non-Ferrous Metals Research Association for the year 1960 became available at the forty-first annual general meeting and luncheon, which was held at the Savoy Hotel, London, on May 10, 1961, in accordance with previous practice. Earlier that week a press conference had been held in the headquarters of the Association, in Euston Street, London, N.W.1, where the visitors were given an opportunity of touring the laboratories. These have been growing as planned and the newly-extended block was described and illustrated on the occasion of its opening two years ago. (See THE ENGINEER, May 29, 1959, pages 846–7.)

In the minds of nearly all makers and users of non-ferrous metals the B.N.F.M.R.A. is now well established as covering the whole of one facet of metallurgical research. Other D.S.I.R. research associations cover other facets, such as Iron and Steel, Welding, Cast Iron, Shipbuilding, Steel Castings, Electrical and Allied, Coal Utilisation, Glass Industry, Ceramics, and Coke. Each and all of these are of substantial potential value to the users of metals; their memberships change as firms amalgamate and there has been a tendency for iron and steel works to be larger than the non-ferrous metal works. Hence one notes that there were in 1960 some 452 members of the British Iron and Steel Research Association and 632 members of the British Non-Ferrous Metals Research Association. The wide interest of many of the larger engineering firms causes one to find their names as subscribers to more than one of these teams of specialists. In all there are over fifty research associations now fathered by the D.S.I.R., which is the Government Department responsible for them.

The Annual Report of the B.N.F.M.R.A. now before us shows progress on more than sixty major researches that were planned to improve the quality, durability, reliability and performance of non-ferrous metals and their alloys. The B.N.F., as this association is commonly called, is supported by both industry and Government. It has been carrying out research and providing technical services for producers, manufacturers, and users of non-ferrous metals from its headquarters in London, to which it moved in 1930. Its laboratories there now cover some 53,000 square feet and its services entail an expenditure of some £250,000 per annum. Its membership now includes primary producers in the Commonwealth, and firms producing sheet, strip, wire, rod and tube from non-ferrous metals in this country; also copper and aluminium alloy founders, die casters, galvanisers, electroplaters, and many engineering firms in the aircraft, electrical, nuclear power and motor manufacturing industries.

Two trends stand out:

(1) Side by side with its fundamental research work, more attention is now being given to development work, and short-term specific investigations, in order that useful results may be passed on as soon as possible to industry.

(2) There is increasing activity among the primary producers to promote international research into further applications for non-ferrous metals and their alloys. This trend to international co-operation in research has, in the case of copper, cobalt, and zinc, led to the placing of contracts with the B.N.F.

By tabulating the B.N.F.M.R.A. "Industry Committees" and their "Research Committees" one gains a good oversight of the two aspects of their work; for whom they do it, and what they investigate, thus:

B.N.F. Industry Committees	B.N.F. Research Committees
Aluminium, Magnesium and their alloys	Analysis.
Copper, Nickel and their alloys	Smelting and Refining.
Lead, Tin and their alloys	Melting and casting.
Metallurgy of Nuclear Energy	Working.
Zinc and Galvanising	Jointing.
Chemical and Electrochemical finishes	Finishing.
	Plant and equipment.
	Properties of Non-ferrous Metals:
	(*a*) Corrosion resistance.
	(*b*) Mechanical properties.
	(*c*) Other properties.

From the B.N.F. research work, which ranges from the study of rare nuclear metals to the everyday galvanising of domestic water tanks, one may select the following items as being of obvious interest to many engineers:

Long research and service testing of chromium plating has resulted in firm proposals for improving its durability, which should lead to better car components.* Real progress has been achieved because B.N.F. specimens of plating have withstood a full year's exposure in one of the world's most corrosive locations, on the roof of the laboratories at Euston: that is a much better performance than is normally experienced with the plated fittings of mass produced motor cars. The B.N.F. is now conducting tests at a provincial factory to try out these new methods of plating on a normal production line, and at an economic cost.

The Clean Air Act presents special problems to firms manufacturing copper and aluminium alloys, because the fineness of the particles released into the atmosphere defeats normal air washing equipment. Firms must, however, tackle this difficult problem, so the B.N.F. has a team in the field experimenting at a dozen plants with existing types of equipment. They will thus be able to help firms with advice on the most effective, in co-operation with the Chief Alkali Inspector of the Ministry of Housing and Local Government, under whose jurisdiction copper and aluminium alloy plants come.

*See THE ENGINEER, August 5, 1960, pages 236-7.

Many of the B.N.F. investigations have been in relation to metal corrosion and fatigue. The past year has seen the successful ending of research into impingement attack of polluted waters on condenser tube alloys. It has certainly been in part because of the valuable work of the B.N.F. in this field that Britain has become a leading world exporter of condenser tubes for vessels, as well as for power stations and oil refineries which draw their cooling water from coastal waters.

The B.N.F. has done pioneer work in devising certain highly successful tools for production control. Its roller stretcher for correcting strip for rolling faults is in commercial production and is attracting interest abroad. Its plating gauge for measuring the thickness of nickel plating, and the later coulometric gauge that is of more general use for measuring the plated coating, have both been put on the market during recent months.

Those interested in laboratory control of the quality of metals will be pleased that during the past year the B.N.F. have shown that the automatic analysis of alloys is possible by an X-ray method, which types the result on a paper in a few minutes. The next step is to be the production of a short list of standard alloys on a B.N.F. rating as a guide to individual firms and others using X-ray fluorescence as their testing method.

Creep resistance still remains a matter of importance to many users of non-ferrous metals, and it has been the subject of fourteen B.N.F. researches.

As the last of this selection one may note that some B.N.F. corrosion research has led to the suggestion of new kinds of water treatment. These should result in a diminution of corrosion troubles with water mains and domestic water fittings, and they are already being tried out in practice in pilot plants by some water undertakings.

Nickel from Manitoba

A major event in the metallurgical world has been the recent starting of nickel production at Thompson, Manitoba. It has come at a useful time both on account of increased usage of nickel and because, for the present, the nickel production capacity in Cuba has ceased to be available to the Western world. The annual meeting of the International Nickel Company of Canada, on April 19, 1961, occurred, therefore, at an auspicious time, as the new nickel mining and refining enterprise in Manitoba had

been formally dedicated on March 25. Four years ago when progress of the construction in northern Manitoba was reported it was planned to start nickel production in 1961. This was an ambitious schedule, including as it did the creation of electrical generating stations, housing, mines and smelters in virgin country, but it has been achieved on time. In a matter of weeks the new plant should be turning out nickel at the rate of more than 75,000,000 lb weight a year.

The new chairman of the International Nickel Company of Canada, Ltd., is Mr. Henry S. Wingate, and he congratulated his predecessor, Dr. John F. Thompson, who was chairman and chief officer of the company when this ambitious project was started, and from whom it has now been named.

Three new uses of nickel have recently deserved attention by engineers, they were :

(1) The metal skin of the N.A.S.A. experimental aeroplane, which recently achieved the greatest speed ever attained by such a manned vehicle, reached a temperature of 700 deg. Fah. during flight yet retained its strength. This aeroplane's skin is made of "Inconel X" alloy, one of a series of high-strength, high-temperature nickel alloys developed and produced by the company.

(2) By contrast, to stress the versatility of nickel, it may be recalled that last year the company demonstrated a 9 per cent nickel steel that it had developed for use in storing liquefied gases at temperatures as low as 320 deg. Fah. below zero.

(3) For applications involving exceptionally high pressure and stress, a new nickel steel was announced by the company on March 16. It contains 18 per cent nickel as well as lesser amounts of cobalt and other elements ; its useful combination of properties has not been realised in other compositions.

The International Nickel Company has thus been successful in both producing more nickel and in building new markets for nickel. The prospects for business in the future rest on the enormous proved reserves of ore and on markets for nickel that continue to expand. The new Thompson project that has added so much to the ore reserves for years to come is now the second largest producer of nickel in the world. Only the Sudbury District operations in Ontario are larger.

During 1960 the company delivered a record weight of nickel, nearly 352 million lb including 51,000,000 lb of purchased nickel. These purchases of the metal are to continue during 1961, lessening the U.S.A. Government's accumulations of surplus nickel, and helping the company's own stock position thus giving users more assurance of the reliability of nickel supplies than they had for many years. This return to normal commercial business in nickel is obviously to be welcomed and, as Canada will herself use relatively little of the nickel she produces, much should now be available for export to the industrial countries of the world, where the use of nickel has all too often been rationed during the past decades. The International Nickel Company is continuing its search in Canada and the world over for economic nickel ores ; as in each of the recent years it plans to spend 8,000,000 dollars in exploration during this year.

It is of interest to see how the European nickel market has expanded during recent years in the five largest consuming countries (see Fig. 1) ; the outstanding increase in consumption of nickel occurred in West Germany. The purposes for which nickel was used during the same period (see Fig. 2) are similarly of interest in that they show the especial growth of the use of nickel in the manufacture of stainless steels in the free world. The nuclear energy industry took much of this but increasing amounts are now reaching the consumer industries.

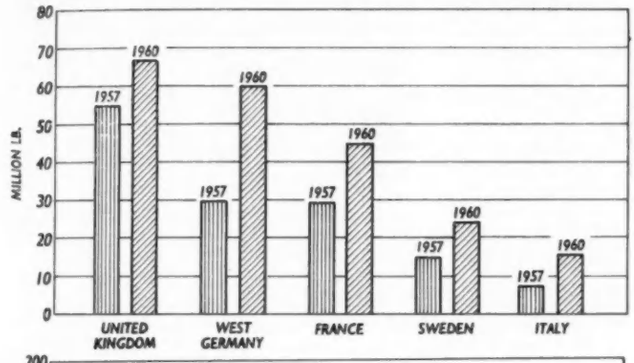


Fig. 1—Growth of European nickel market (estimated consumption—five largest consuming countries)

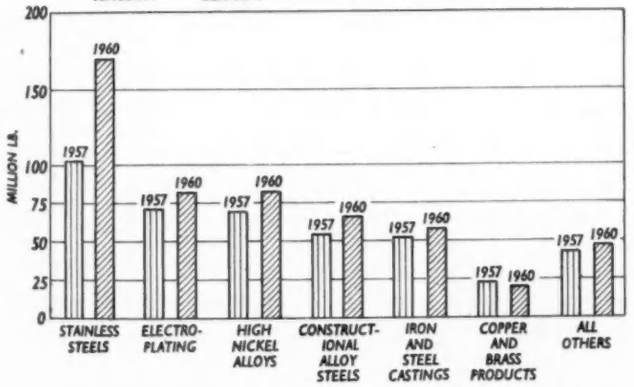


Fig. 2—Where nickel is used (estimated free world consumption)

A New Metals Handbook

When the writer recently received his copy of the American Society for Metals' 8th Edition, Volume 1 of the *A.S.M. Metals Handbook* entitled "Properties and Selection of Metals," his first reaction was to weigh it, just under six pounds on the scales, and to measure it, 11¼in by 8¾in and 2½in thick! Clearly this tome is the largest available storehouse of useable knowledge on metals : posted to addresses outside Canada and the U.S.A. it is priced at 32 dollars, but it will be worth that and more to many libraries.

The contents of its 1300 pages are divided into sections headed as follows :

Definitions and Reference Tables ; Carbon and Low-Alloy Steels ; Cast Irons ; Stainless Steels and Heat-Resisting Alloys ; Tool Materials ; Magnetic, Electrical and Other Special-Purpose Materials ; Aluminium and Aluminium Alloys ; Copper and Copper Alloys ; Lead and Lead Alloys ; Magnesium and Magnesium Alloys ; Nickel and Nickel Alloys ; Tin and Tin Alloys ; Titanium and Titanium Alloys ; Zinc and Zinc Alloys ; Precious Metals ; and Properties of Pure Metals.

This is only Volume 1, but the magnitude of the work entailed in its production is truly surprising. The A.S.M. Handbook Committee, in conjunction with the Society's editorial staff, organised eighty-three committees, whose 1300 members came from more than 500 plants and from virtually every A.S.M. Chapter, as their local sections are named, in the U.S.A. and Canada. Forty thousand copies were printed and they needed some 260,000 lb of paper. In its planning, editing, production, and world-wide distribution this new A.S.M. *Metals Handbook* has been a major engineering achievement. It sets out to be the outstanding guide to the selection and use of all types of metals.

A Great Metallurgical Editor

When Ernest E. Thum was accorded the numerals 1884–1961 in April the metallurgical world was conscious of the ending of a long and useful reign. They have to thank Thum for a quarter of a century of service to the American Society for Metals and in particular for his skill and devotion in editing *Metal Progress*. The style of production that he achieved in that journal blends colour, conciseness and understandable English while presenting complex metallurgical news. He was unfettered by the traditions of sober solemnity to which the scientific societies of Europe adhered and which pure scientists still prefer. Technologists, however, revelled in the useful news that the mass of clever advertisements always contains on either side of the central editorial matter. Many of the British engineering and metallurgical institutions now similarly mix advertisements with their scientific contributions. Thum had his own American variety of artistic talent that was to be recognised, right from the start, in the high standards of style and layout that made *Metal Progress* immediately distinguishable. Early this year Ernest Thum had been given added responsibilities as Director of Editorial Services which involved the co-ordination of work on all A.S.M. periodical and reference publications.

NITROGEN SHRINKING FOR COMPONENT ASSEMBLY. —Nitrogen shrinking in assembling components for heavy machine tools is to be increasingly adopted at the works of Bayliss, Jones and Bayliss, Ltd., Wolverhampton, following two successful test shrinkings, supervised by technicians from the British Oxygen Company, Ltd., Bridgewater House, St. James's, London, S.W.1. Nitrogen shrinking involves immersing a metal component in an insulated tank of liquid nitrogen (boiling point −195·8 deg. Cent.) for a period varying according to the metal concerned and the amount of contraction required. One of the test pieces was a gear wheel pinion for a 300-ton billet shear and the spigot of the pinion, with a diameter of 7·999in, was contracted to fit the wheel bore of 7·993in. The shrinking operation took only thirty minutes and used 56 gallons of liquid nitrogen (equivalent to 8000 cubic feet of gas) which was supplied direct from a B.O.C. road tanker.

Machinery at the Royal Show

No. I

The Royal Agricultural Society's annual show opened at Cambridge on Tuesday morning and closes this evening. The site on which the show is staged this year covers 170 acres, whilst a further 125 acres of adjoining ground are being used for car parks. Trade and educational stands—there are 550 in all—occupy something like two-thirds of the Royal showground.

THE Royal Agricultural Society of England held its first show or "county meeting" at Cambridge as long ago as 1840, and this years' show is the sixth to be held there. The 1962 Royal Show will be held at Newcastle upon Tyne, after which the show will move to its permanent site at Stoneleigh Abbey, Warwickshire. Although this year's display is impressive and the number of machinery and implement exhibits runs into thousands, reference to our survey of the meeting held a hundred years ago at Leeds suggests that that show was equally impressive and some of the exhibits no less ingenious. We noted at the time that there were "... considerably more than a hundred articles (many of which were represented by several dozen specimens) which the compilers of the catalogue, with all their powers of generalisation, were unable to classify ..." We added that we were alluding only to the implement catalogue, an octavo volume of over 400 pages. There was a separate catalogue for the "beasts."

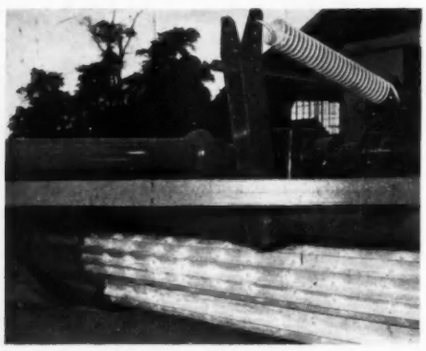


Fig. 1—Catchpole hay conditioner, showing the crimping rollers

The engineering industry plays an increasingly important part in modern farming methods, as can be seen by the almost bewildering range of machinery and equipment displayed on the trade stands. But this year the demonstration area has been enlarged from six to sixteen acres, and more equipment can be seen at work. The National Institute of Agricultural Engineering has organised a demonstration of the techniques of bale handling, a subject in which there is much interest at the present time, and the equipment which can be seen working here under field conditions includes bale-throwing attachments, baler-to-trailer elevators, bale sledges, pallet loaders and buckrake bale handlers. Another demonstration is of stock on slatted floors and the liquifying of the sludge which falls through the slats, and its controlled distribution by liquid manure spreaders and by irrigation.

The 1961 forestry exhibit is experimental and the whole site has been laid out to form one continuous demonstration. The theme this year is "Seed to Saw." A variety of machines are to be seen extracting poles from a plantation and hauling them to mobile saw-benches and bark peelers, for conversion into fencing, pitprops and pulpwood—the main outlets for thinnings. Mature timber is taken to the sawmill, a complete representation of which is on show.

Silver Medal Entries

Each year, the Royal Agricultural Society awards silver medals for machines or implements judged to be entirely new in principle or purpose. The "Burke" perpetual challenge trophy may be awarded to the winner of a silver medal whose entry is considered of outstanding merit. Amongst the eleven entries which have been accepted for adjudication this year are a diesel tractor, a hedge cutter and trimmer, a hay conditioner, a grain cleaner, a metering hopper and a spading machine. Five other entries have been deferred for completion of test or farm inspection.

An alternative to ploughing the land is offered by use of the "Rotaspa" spading machine which is exhibited by F. T. Ruston and Son, Ltd., St. Ives, Huntingdon. The machine is attached to the tractor's three point linkage and is driven from the power take-off. Its weight, with accessories, is about 1650 lb and the hydraulics of the tractor must be able to lift this weight some 20in above ground level and carry the machine during transportation. The machine has six sets of three spades which are of hardened steel and are replaceable. For normal operation the rotation speed of the shaft is from 25 to 35 r.p.m., which, with an average forward speed of the machine of 1 m.p.h., enables about ¼ acre an hour to be dug. In operation each spade chops into the soil, carries a clod beneath the main shaft of the machine and then lifts it clear of the ground before tilting and depositing the clod either entirely or partly turned. In certain cases, such as stubble ploughing, coulter knives are undesirable and wide spade blades should be used, but for heavy and overgrown soils seven coulter knives

Fig. 4—The "Ideal Rothery" grain cleaner fitted with a special chute, being used in the field to clean grain stored in a temporary silo

Fig. 2—J.E.C. Grasslands sod-seeder

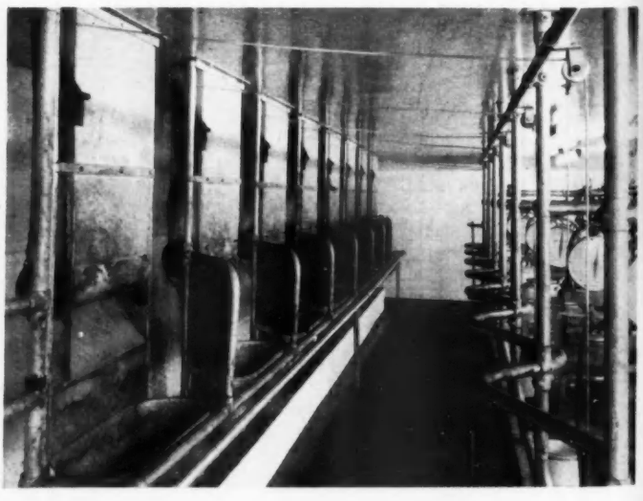


Fig. 3—Gascoigne metering hoppers installed in a herringbone milking parlour

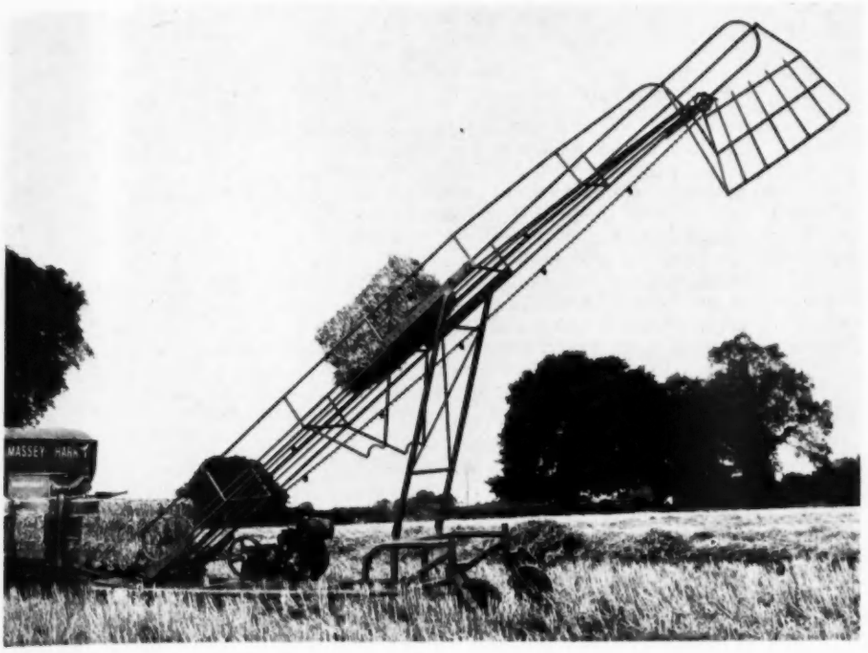


Fig. 5—The " Balevator " shown collecting bales directly from the baler

are fitted in order to cut the soil, and in this case narrow spade blades are used. The machine works to a depth of 12in, its working width being 7ft. Its overall width is 9ft.

The new hay conditioner shown by the Catchpole Engineering Company, Ltd., of Bury St. Edmunds, Suffolk, is driven from the power take-off of any standard tractor having a power take-off speed of 540 r.p.m. The machine consists of two meshed angle rollers, both of which are chain-driven direct from the tractor power take-off through a gear box. The rollers which can be seen in Fig. 1 crimp the hay, thus letting the moisture out and assisting its rapid curing, without shattering or crushing the stems and leaves. The crimping rollers can

Fig. 6—The Barford bale loader attached to the tractor front-end loader

be adjusted to suit different types of crop. A gauge roller is fitted which prevents the pick-up rollers from coming into contact with the ground and avoids damage to the plant. The speed of operation depends to a great extent upon the particular terrain and the density of the crop being handled, but as a general rule, the makers say, work can proceed at some five to six m.p.h., with the tractor being driven at full throttle.

The machine has a working width of 5ft, its overall width being 7ft 3in. Its working height can be adjusted by a hand-crank, and windrow wings can be set to give the required width of swath. Deflector shields are adjustable to give shallow or deep fluffing of the crop. The main frame of the machine is constructed from rectangular tube and channel section pressings and is carried on 600×16 pneumatic wheels which have sealed roller bearing hubs.

The four-wheel drive diesel tractor shown by County Commercial Cars, Ltd., Fleet, Hants., known as the " County Super 4," has the same engine specification as the Fordson " Super Major " tractor (THE ENGINEER, December 2, 1960). The tractor has only one differential, final transmission to the front wheels being from twin forward-extending propeller shafts driven by bevel gears mounted on the outer ends of the rear transmission countershafts. The propeller shafts are telescopic and drive twin spiral bevel crown wheels and pinions in individual casings pivotally mounted on to the front axle beam. The steering brakes operate on all four wheels, which are of equal size. Power assisted steering is standard on this tractor.

The " Multipull " hitch on the stand of Massey-Ferguson (United Kingdom), Ltd., was described in detail in our issue of September 16, 1960. It is designed to provide a constant transfer of weight from a trailed implement or a four-wheeled trailer to the rear wheels of the tractor.

The grasslands sod-seeder shown in Fig. 2 has been entered this year for the Society's silver medal award by Jeffrey Engineering Company, Ltd., St. Oswald's Road, Gloucester. It is claimed that the machine will work directly over any pasture or grassland that has been well grazed or cut. Mounted on a nine-tined spring cultivator, the combined seed and fertilizer drill is driven by a land wheel. The seeding boots cut a series of bands 2in wide, about 1in deep and 10in apart, into which seed and fertilizer are fed in precise amounts and are finally covered with a layer of soil. The machine was designed to introduce new plant life to existing pastures which require renovation and improvement without incurring the loss of grazing facilities normally experienced in a complete re-seeding programme.

Metering hoppers, designed on a volumetric measuring basis, for the accurate rationing of feed for milking parlour systems are being exhibited by Gascoignes (Reading), Ltd., Berkeley Avenue, Reading. The hoppers, which are shown installed in a milking parlour in Fig. 3, are filled directly from bags, by gravity feed from an overhead loft through metal trunking, or by auger conveyor fitted above the hoppers delivering from bulk storage bins. The metering device is basically a cylindrical drum, with an adjustable segment which can be opened or closed depending on the feeding stuff being used and the quantity to be delivered. It can be adjusted to deliver from 1 lb to 3 lb.

The " Ideal Rothery " grain cleaner manufactured by Gordon Felber and Co., Ltd., Spirella House, Oxford Circus, London, W.1., and shown in Fig. 4, is made up of a 16ft galvanised metal tube, carrying inside it a helically bladed screw conveyor. The

Fig. 7—Ransomes FR. TS. 82 two furrow reversible plough

top half of the tube is perforated and thus forms a screen through which dross, weed seeds &c., are ejected as the grain is carried upwards. The rejected material is caught in a trough which is fitted beneath the conveyor tube, whilst the grain is carried to the top end of the cleaner from which it drops into a blower unit for the separation of seconds, straw and chaff. Motive power is provided either by an electric motor mounted at the top of the conveyor tube or by a petrol engine mounted on a bracket fitted to the legs of the blower unit.

The amount of mechanical handling equipment exhibited at the Royal Show increases year by year. Two such pieces of equipment, which are amongst the silver medal entries deferred for completion of test or farm inspection are the "Balevator" manufactured by Gordon Felber and Co., Ltd., and the bale loader attachment made by Barford of Belton, Ltd. The "Balevator," Fig. 5, consists of a tubular steel chassis which is connected to the rear of the baling machine by a triangular link which allows it to move freely about a horizontal axis. The rear of the chassis is carried on two rubber-tyred wheels. A chain conveyor, mounted on the chassis, collects the bale as it is ejected from the baler and carries it backwards to the upper end of the elevator, where specially positioned rails edge the bales on to a chute, from where they drop on to a trailer being towed alongside the "Balevator." The unit is driven independently by a four-stroke, 3 h.p. petrol engine mounted on the chassis and connected to the conveyer by chain drive. It can also be driven by a flexible drive from the power take-off of the tractor.

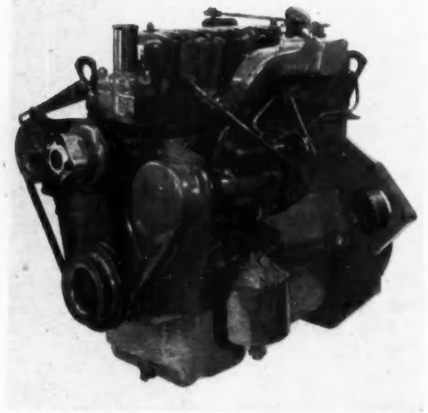


Fig. 8—Perkins "Four 107" agricultural diesel engine

The bale loader made by Barford of Belton, Ltd., Belton, Nr. Grantham, has been designed for attachment to any of the now familiar hydraulic front-end loaders. It is fitted in place of the front-end loader bucket, as can be seen in Fig. 6. It has very few moving parts and its only controls are the hydraulic ram which raises and lowers the front end loader, and a cord operated by the tractor driver which unlocks the arms of the bale loader from either the open or closed positions.

The arms of the bale loader close automatically on, and grip, the bales as the front-end loader arms are raised by the hydraulics, and having gripped the bales, the arms are locked automatically until the release cord is pulled. When unlocked, the bale loader arms open as the front-end loader arms are lowered hydraulically. The bale loader can handle up to nine bales in each lift. Its loading height is from 11ft to 13ft.

Some Other Exhibits

Amongst the range of tillage and harvesting machinery on the stand of Ransomes Sims and Jefferies, Ltd., are the new FR.TS.82 two furrow reversible plough and FR.TS.78 5/4 furrow semi-mounted plough. The new reversible plough, Fig. 7, has exceptional underbeam and interbody clearance allowing the fitting of single arm swivel disc coulters. It can be adjusted for furrow widths of 12in and 14in and can plough to a depth of 12in. Four different bodies, to suit a variety of soils, are available. The TS.78 semi-mounted plough has a rear-mounted rubber tyred wheel and hydraulic lift for transport purposes. A two-position headstock gives true-line draught. The plough can be adjusted for either 10in or 12in wide furrows with a maximum depth of 8in.

A new four-cylinder diesel engine for agricultural applications, the "Four 107," illustrated in Fig. 8, is being shown by Perkins Engines, Ltd. Developing 41 b.h.p. at 3000 r.p.m., the engine is claimed to be particularly suitable for small self-propelled combine harvesters where a constantly accurate speed is desirable. The engine has a 3·125in bore by 3·5in stroke with a capacity of 107·4 cubic inches. Maximum torque is 80 lb feet at 1800 r.p.m. Design features of the engine are similar to the agricultural version of the 1·6 litre "Four 99" engine (The Engineer, January 30, 1959). It weighs 456 lb with accessories.

(*To be continued*)

Economical TV Broadcasting Station

A SIMPLE design of low-cost 625-line television broadcasting equipment has been developed by Pye T.V.T., Ltd., of Cambridge. It is known as the "Cambridge TV Station" and is intended to bring television broadcasting services within the reach of smaller communities which are unable, at present, to bear the cost of more comprehensive installations. The system is suitable for general TV programmes—such as news presentation, interviews and educational broadcasting—but not for the live transmission of rapidly moving subjects. The "package" installation with equipment for the studio and control room, together with Teleciné sets, transmitters, mast and aerial and cables costs £17,000.

Fig. 1—"Staticon" camera for the "Cambridge TV Station"

The studio equipment consists of two tripod-mounted cameras, four microphones, a studio loudspeaker and a basic lighting system. In the control room the installation is a console equipped for monitoring and mixing functions; two 16mm Telcciné sets with slide projectors; two transcription/gramophone units; a monitor loudspeaker; two equipment cubicles and the sound and vision transmitters. An aerial system and 100ft mast are supplied, with stays, for erection alongside, or on top of, the station building.

One of the cameras is shown in Fig. 1. It embodies a 1in photoconductive "Staticon" pickup tube, an 8½in monitor viewfinder and a transistor talk-back amplifier. There is a manually controlled four-lens turret carrying 16mm C-mount lenses with optical focusing. A cue light is fitted. The monitor viewfinder is of the same design as those used in the control room. Camera units are interchangeable and can easily be removed from the casing which is cooled by an internally mounted fan.

The control room console, shown in Fig. 2, is designed to be operated by one person during

Fig. 2—The control console of the "Cambridge TV Station" contains camera control units with basic monitoring and mixing circuits

off-peak hours or by two or more people during more elaborate presentations. As illustrated, the all-metal console is fitted with the following equipment: four 7½in video monitors, one 14in precision monitor, four camera control panels (two for studio cameras and two for Teleciné, one vision mixer, one 3in waveform monitor (in the central panel), two four-channel transistorised audio mixers, one sound control panel and one Teleciné control panel.

Two complete Teleciné sets are supplied, each incorporating a basic staticon camera unit and professional Philips "EL 5001/88" projector for 16mm film; one is equipped with two slide projectors and optical multiplexer. Spool sizes up to 4000ft can be used, enabling the projection of up to 105 minutes of programme. Both units are mounted on steel columns. The high quality 2in by 2in (35mm) Leitz "Pradovit" slide projectors have magazines which will hold thirty slides. Remote control of the Teleciné and slide units is provided at the control console on the Teleciné control panels.

The two transcription units that are supplied incorporate standard Pye correction amplifiers, each with prefade facilities and output level control. Each unit includes a Garrard 301 professional turntable, together with Decca plug-in heads and S.M.E. arm.

The main electronic equipment not requiring direct control is housed in two 7ft fan-ventilated enclosed cubicles. This equipment includes: two sync. pulse generators (one in use, one in reserve); four camera control units (two for cameras, two for Telecinés); two camera auxiliary units (for Teleciné aperture correction); and loudspeaker drive facilities.

The vision and sound transmitters together with their power supplies are housed in a single cubicle. The vision transmitter supplied preset for operation on any one channel in the C.C.I.R. Band-I, produces a 100W peak sync. output. R.F. drive is crystal controlled. The sound transmitter is supplied adjusted to the complementary sound channel for the vision channel in use. It has a frequency modulated output of 20W. Alternatively a 100W transmitter designed to F.C.C. standards is available, if required.

The antenna system employed will normally take the form of two simple omni-directional radiators, one for vision and one for sound, mounted on a 100ft lattice type mast. It is intended this mast would be sited in close proximity to the studio centre. A length of 400ft of feeder cable is included in the standard offer. The aerial systems normally supplied for sound and vision each consist of a simple folded dipole made up of two arms at 90 deg., the two dipoles being stacked one above the other. Other designs of mast and aerial are available.

Normally all the equipment supplied with the package station described here is for single-phase operation, in the voltage range 110V to 250V a.c. at 50 c/s, but 60 c/s/ can be supplied to special order.

The total single-phase loading of the equipment is 11kVA of which 5kVA is absorbed by the standard lighting equipment. The studio lighting equipment, including bulbs and reflectors, is designed to light 200 square feet of floor area, with an overall ceiling height of 12ft to 14ft.

[Reply Card No. 1080]

Semiconductor Production

OPENING the new plant of Texas Instruments, Ltd., at Manton Lane, Bedford, on June 27, Sir John Cockcroft expressed the hope that the rapid development of semiconductor technology would reduce the costs of fast computers so much that they could be available to many universities five to ten years from now. He thought the company's recent development of an ultra-fast switching transistor, which would perform switching operations in twenty-four millimicroseconds, should be of special importance in computer progress. Solid state circuits, also, would be important technically in the functioning of very high speed computers, where one came up against limitations set by the velocity of radio waves. They carried miniaturisation of circuits one or two orders of magnitude down the scale, so that in future 1000 circuit elements might be stored in a cubic centimetre. He was interested to learn that the company was studying the possibility of transistors being made from organic materials, following promising work in the chemical industry, and that the commercial possibilities of refrigeration using the reverse Peltier effect in semiconductors were being explored. This kind of refrigeration already had application in space technology. Sir John concluded by exposing a solar cell and pressing a key which caused the cell current, through a solid-state multivibrator, transistor amplifier, controlled silicon rectifier, and a transformer, to produce a spark which burned through a ribbon across the entrance to the factory. After the ceremony he was handed a letter by Mr. P. E. Hagerty, President of Texas Instruments, Inc., of Dallas, which stated that the company would enter into a seven-year contract with Churchill College, Cambridge, pledging £750 annually for that period.

The new premises at Manton Lane cover 132,000 square feet. They comprise a three-storey office block 270ft long and 50ft wide, surrounded on three sides by the two-storey manufacturing area, with open garden courts between them. The roof of the manufacturing area is of anticlastic shell construction, the units being 48ft square, rising from 9ft at the springing to 18ft at the edges. The interior views which we reproduce show the unencumbered floor space which has been obtained, since each unit covers 50 square feet of floor space and is supported by a single central pillar. This type of roof was described in our June 10, 1960, issue, page 974. External brick towers at intervals along the length of the building function as service shafts between the manufacturing area and the continuous 10ft high services space below it. The piped services are fed up through the floor at 10ft intervals. Air-conditioning is provided by a main fresh air plant and thirty recirculating plants, all served by a 350 h.p. refrigerating compressor. The architects for the factory were O'Neill Ford and Richard Colley, of Texas; the consulting engineers were Oscar Faber and Partners; and the general contractor was Tarmac Civil Engineering, Ltd.

Visitors to the opening ceremony were conducted round the manufacturing area, the tour including an inspection of exhibits illustrating applications of semiconductor devices. Among these were the use of two silicon transistors as a telephone cross-point static switch, and a motor speed control system using silicon power transistors with variable mark/space ratio switching. The materials group of the development section showed an 8W thermo-electric generator in which lead-telluride elements are heated on one side and fan-cooled on the other.

In the production departments three silicon crystal growing machines were seen in operation, one having a vacuum furnace and the others an argon atmosphere. The use of a Shefield "Cavitron" ultrasonic device for cutting wafers was demonstrated. Automatic devices used in later stages of production include a glass sealing machine handling 1000 devices an hour, a device for loading diffused wafers into their cans at the rate of 5000 an hour, a continuous in-line etching and washing plant feeding into a bake-out oven, and an auto-test machine with grading by punched cards. A quality assurance section continuously applies stringent tests to finished devices, both of assembly and ability to withstand extreme conditions of temperature and humidity. A "Veeco" leak detector has a capacity of 1000 devices an hour. The devices are warmed in helium at a pressure of 4 atmospheres, after which a mass spectrometer detects the rate at which helium emerges under vacuum.

(Left)—Crystal growing machines for semiconductor devices. (Right)—Assembly and test lines for semiconductor diodes and transistors. Both views show the anticlastic shell roof construction which frees floor space by minimising the number of supporting pillars

SHORTER REPORTS

Water Supply Works in Hong Kong

THE Shek Pik water supply scheme in Hong Kong has now reached the stage where work has started on laying the 7½ miles of submarine pipeline (2½ft in diameter) which will link the filtration plant at Silvermine Bay, Lantau Island, to Sandy Bay pumping station on Hong Kong Island.

Work is being carried out on the first section using a floating lay-barge. This section is from Silvermine Bay to a connection chamber north of Chau King Island. Eighty-one-foot lengths of pipe are welded together on the barge and lowered into the sea as the barge moves away. In the second phase this procedure will be reversed, that is, the pipeline will be pulled from the barge, which will remain at anchor in the channel between Chau Kung and Hong Kong Islands. The pipe will first be pulled from the barge to the shore at Sandy Bay, and then the barge will be turned and the pipe pulled from the barge to the connection chamber.

The pipes were prepared in 27ft sections on the Hung Hom reclamation. There they were welded and radiographed for faults. The whole pipeline is coated outside with coal-tar enamel reinforced with glass-fibres, felt, and 3in layer of reinforced concrete for weight, and inside with polyurethane. It will connect the Shek Pik reservoir with a new main 30 m.g. reservoir which is being built on the slopes of Mount Davis, Hong Kong Island.

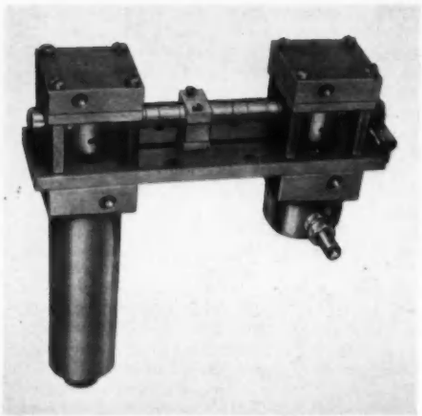
Shek Pik reservoir will impound 5350 m.g. and will yield 26 m.g.d. ; it utilises a system of catchwater aquaducts and tunnels commanding the whole of the southern and western parts of Lantau Island. From the reservoirs the water will be delivered through a supply tunnel to a pump-house at Pui O and then by pipelines to the fitration plant at Silvermine Bay before entering the submarine pipeline already described.

Drysdale and Co., Ltd., Yoker, Glasgow, has recently received a contract worth over £200,000, for the supply of the pumping and ancillary equipment for the Sandy Bay pumping station on Hong Kong Island, where water will be repumped to large service reservoirs. The main equipment being supplied under this contract includes seven vertical centrifugal pumps having a combined capacity of 60 m.g.d., pump motors, switchgear, electrical instrumentation, transformers, diesel alternators, &c. The works to be undertaken in Hong Kong Island, of which Sandy Bay pumping station is a part, are the responsibilities of the Public Works Department of the Government of Hong Kong, in collaboration with the consulting engineers, Messrs. Binnie Deacon and Gourley, who are responsible for the other sections of the scheme. The Shek Pik scheme was described in THE ENGINEER of June 29, 1960, page 1059.

Ratio Totaliser Relay

WHERE one or more flow signal transmitters and a pressure or temperature transmitter are used in a control system, it is necessary to employ one or more pneumatic relays in which the various signals are combined to produce the final "action" output for the variable under control. For this function a ratio totaliser relay has been introduced by Hagan Controls, Ltd., 14, Grosvenor Place, London, S.W.1. The relay, illustrated herewith, consists basically of three receiving chambers containing sensitive diaphragms, and a fourth transmitting chamber containing a pilot valve and diaphragm. The four chambers are mounted in opposing pairs, the pairs being interconnected by a balance beam carried on a thin sheet steel fulcrum, adjustable in position over wide limits. The output from the relay equals the algebraic sum of the moments of the three input pressure signals.

In its standard form, the relay can perform simple addition, subtraction, comparison, multiplication, division, averaging of two input signals, provide proportional control action with or without integral (reset) action, or provide derivative (rate) control action ; relays used in pairs will select the higher or lower of two



Adjustable pneumatic relay for combining signals to produce control effect

input pressures. When fitted with a spring barrel the relay can provide proportional control against a fixed set point with or without reset action, reverse an input loading pressure, split an input into two ranges, convert one signal range to another range, or provide pneumatic toggle switching action. The fitting of bellows elements in place of diaphragms in the input chambers increases the pressure range that the relay can accept and the range of its multiplication and division capabilities.

[Reply Card No. 1073]

Indicating Pneumatic Temperature Controller

FOR controlling the working temperatures of vats, autoclaves, and similar containers, or for refrigerating, air-conditioning and similar plants, an indicating pneumatic controller has been introduced by the Cambridge Instrument Company, Ltd., 13, Grosvenor Place, London, S.W.1. Control is operative between −20 deg. Cent. and +340 deg. Cent., the required level being set by the knob and pointer seen in the illustration. The measuring element is a vapour pressure thermometer, of which the temperature is shown continuously on the large dial of the instrument. The measuring system of the thermometer is linked with a flapper valve in the control air system which operates at the selected temperature and causes a diaphragm valve in the pipeline carrying the gas or liquid cooling or heating medium to close. Two small dials on the instrument indicate respectively the control air inlet pressure and the outlet pressure to the diaphragm valve. The controlled temperature can either be that of the process or container itself or, less frequently, that of the piped supplies. The instrument can be used in almost any industrial process where the flow of heating or cooling medium can be regulated by a diaphragm valve.

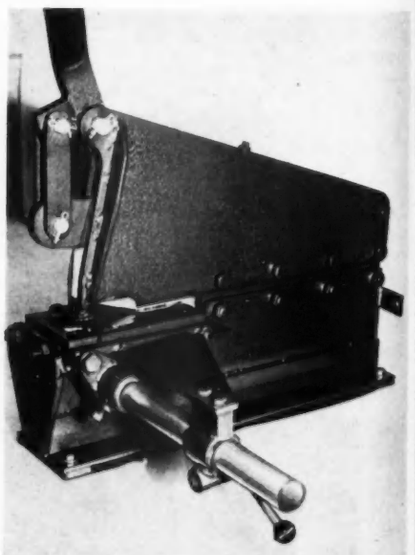
[Reply Card No. 1074]

Pneumatic controller for heating and refrigerating systems

Sheet Shearing Machine

A HAND-OPERATED sheet shearing machine suitable for steel sheet up to ¼in thick or non-ferrous sheet up to ⅜in thick is now made by Ferrous Transformers, Ltd., Church Road, Croydon, Surrey. This machine departs from conventional hand shearing equipment in that it parts a sheet by the progressive cropping out of a narrow strips of metal from the waste side of the cut.

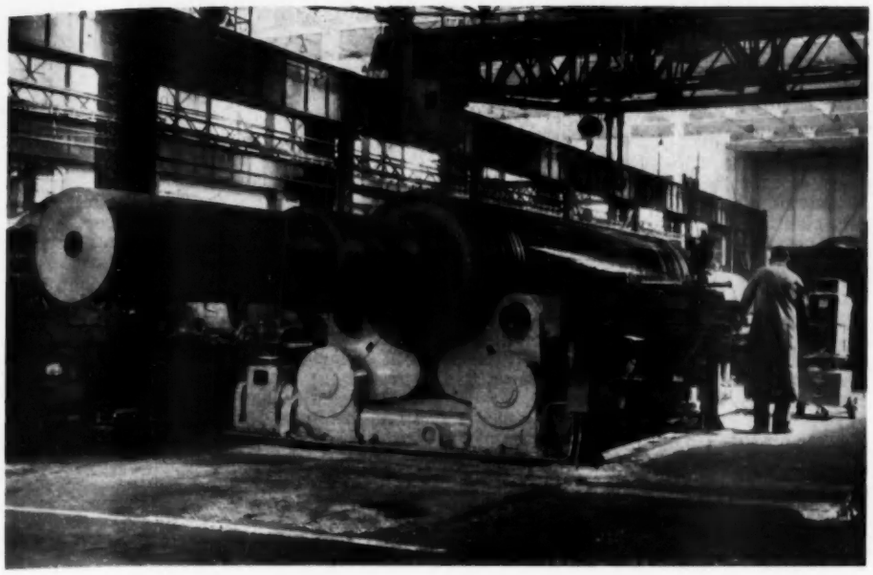
The machine, illustrated below, has a fabricated plate base with a table on which three hardened



Hand-operated shearing machine for ¼in steel or ⅜in non-ferrous sheet

steel plates forming the cropping die are screwed. Provision is made for the adjustment of the die plates to compensate for material ground away in re-sharpening. The head of the machine is bolted to the rear vertical member of the base through a ¼in thick plate. In this head the punch assembly is pivoted at the rear end and is actuated through a lever system to give the shearing motion.

The punch has an effective cropping length of 6in and is built up of a central plate with a blade on each side. The central plate forms a guide which, in operation, is not raised above the level of the die surface. A hardened and ground blade screwed on to each side of the central plate has its cutting edge some distance above the lower leading edge of the plate. The overall width of the punch plate and blades is ¼in, to match the width of the die gap. Facilities are provided for the ready removal of the blades for re-sharpening when necessary.



Rotor under examination on ultrasonic testing equipment

With this design, it will be seen, each stroke of the punch crops a discard 6in long by ¼in wide out of a sheet. At the rear of the throat the slot cut in the sheet passes freely along the length of the plate connecting the head to the base of the machine, providing an effective guide to give straight line shearing. Furthermore the free passage provided when shearing wide sheets avoids twisting and distortion of the work—as is not unusually the case when using conventional hand-operated shearing machines of this type.

An adjustable stop plate supported from a bracket at the side of the machine table and set parallel to the punch blade facilitates the starting of straight cuts. If required this step plate can be removed and replaced by special guides or other devices for particular classes of work. When it is bench mounted a gap must be provided in the bench below the machine for the disposal of discard, and there is also available a pedestal mounting which makes the machine readily portable.

[Reply Card No. 1069]

Ultrasonic Testing of Large Steel Forgings

ULTRASONIC examination by the normal method, holding the probe by hand and sliding it over the surface of an object, becomes tedious when such things as large forgings are being examined. There is also a danger that parts of the forging may not be examined properly. To obviate this risk and to simplify the task of the operator, Thos. Firth and John Brown, Ltd., Atlas Works, Sheffield, 4, has installed equipment which both rotates the forging and traverses the probe mechanically. The operator is thus free to concentrate on the cathode-ray indications.

The apparatus is based on a standard Bode welding positioner, modified by the addition of a variable speed gearbox in the drive, and a traversing head carrying a Kelvin and Hughes ultrasonic probe. A forging is placed in position as shown in our illustration, and rotated at a suitable speed according to its diameter. At the same time the probe head is traversed across the surface of the forging, and the examination is thus carried out in a helical path. By varying the speeds of the traversing and rotating gears any desired pitch of helix, and therefore any chosen degree of coverage, can be obtained. By using a a helix of sufficiently fine pitch it is possible to work with a certain amount of overlap.

The indicating equipment is of the maker's standard Mark 6 pattern. In order to reduce electrical interference which could give rise to false readings on the detector, the leads are screened, and a.c. motors with variable-speed gearboxes are used for both the rotation and traverse motions.

A range of forging sizes from 2ft 6in to 5ft diameter can be handled, the maximum weights and lengths being 60 tons and 46ft respectively. At present, the length of forging which can be examined by the mechanical scanning apparatus is limited to 20ft by the extent of the track carrying the probe head. This is not a serious handicap, as the machine is mainly used for testing large turbo-alternator rotor shafts, and it is only the large diameter central body portion of the forging which is likely to contain defects.

However, the equipment is suitable for any type of forging of uniform circular cross section—forged rolls, for example can be handled by it—and if it should become necessary to extend the examination length, this could be done simply by extending the probe traverser track. No other alterations to the plant would be needed.

[Reply Card No. 1082]

Secondary Radar for Civil Flying

LAST week a demonstration was given at London Airport of a civil secondary surveillance radar system developed by Cossor Radar and Electronics, Ltd., Elizabeth Way, Harlow, Essex. The ground equipment has been engineered to a Ministry of Transport and Civil Aviation specification in conformity with I.C.A.O. requirements, which include the suppression of responses by the airborne equipment to side lobes of the ground aerial radiation pattern. In the Cossor system the interrogating pulse or pulses from a highly directional aerial array are supplemented by a control pulse which is emitted from a substantially omni-directional aerial. The amplitude of the control pulse is such that, except within a few degrees of the axis of the main beam, it is well above that of the interrogator signal. In the airborne transponder, unless the ratio of the interrogator and control pulses exceeds a certain value, the interrogation is not passed on to the reply-generating circuits. In the view of the mobile equipment, Fig. 1, the small centre section of the rotating array contains part of the control aerial elements, while the remainder radiates the narrow interrogator beam.

The present equipment operates on a two-pulse system, the control pulse being followed after 8 or 17 microseconds by a single interrogator pulse. Interrogation with the eight-second delay is known as Mode A, and with seventeen-second delay as Mode B. Mode A is common with that used for interrogating military aircraft. Mode B is confined to civil aviation. The aircraft responder can be switched to answer either mode. Fig. 2 shows the ground equipment.

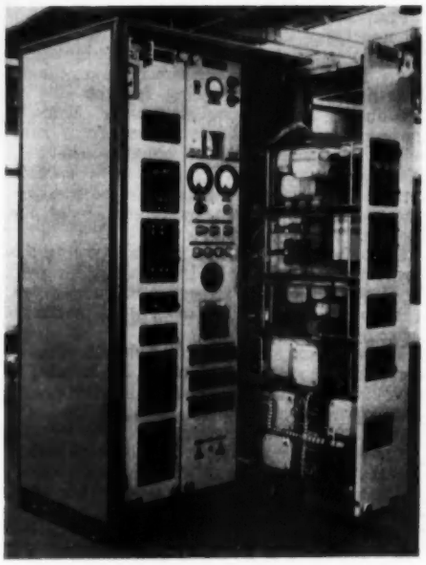


Fig. 2—Secondary radar interrogator-responsor with aerial control servo equipment withdrawn for inspection

The cabinet houses in the left-hand bay the interrogation and control transmitters, responsor receiver and associated circuits; and on the right the circuits of the aerial servo system.

The Cossor airborne transponder equipment measures 21⅞in deep by 5⅛in wide by 8in high and weighs approximately 20 lb. In reply to an interrogation the unit transmits trains of flight information pulses in sixty-four different combinations. A switch on the remote control unit selects the mode of interrogation to which the equipment will respond. The eventual use of two further interrogation modes is envisaged, one of which would obtain altitude information from the aircraft. Provision has been made for

Fig. 1—Aerial of mobile interrogator-responsor for secondary surveillance radar

SHORTER REPORTS *(Continued)*

modifying the transponder so that it will automatically identify the interrogation mode being received and reply with the information appropriate to that mode.

The complete system of ground equipment (S.S.R. 4G) and airborne transponder (S.S.R. 1251/2/3) allows a consistent range of 180 nautical miles for aircraft flying at 30,000ft.

[Reply Card No. 1078]

Asbestos Cement Packing for Cooling Towers

FOR some years the Universal Asbestos Manufacturing Company, Ltd., Tolpits, Watford, Herts, in co-operation with specialists in cooling tower design, has been experimenting on the use of asbestos cement sheeting for the internal packing material of cooling towers. Some of the early experiments were done on a small cooling tower at Leicester power station ; in 1945 this tower was repacked with asbestos cement corrugated sheets stacked vertically in one plane and secured by bronze bolts and spacers.

Since then this simple concept has been further developed by U.A.M. in conjunction with L. G. Mouchel and Partners, who have evolved a simple and effective pack which needs no spacers or fixings.

In this pack 6in corrugated sheets, with the corrugations running vertically, are interleaved with 3in corrugated sheets, with the corrugations running horizontally. The multiple points of contact between the corrugations give considerable strength and rigidity to the packs, so that the sheets can be made somewhat thinner than the normal roofing grade. A substantial saving results, even for a small tower.

Packs of this kind are being used for the first time on the two cooling towers at the new Padiham "B" Generating Station of the C.E.G.B. These towers, designed by L. G. Mouchel and Partners and built by the Mitchell Construction Company, are 300ft high and have a diameter at pond sill level of 190ft. Each tower handles 3,500,000 gallons of cooling water per hour and produces a temperature drop of about 18 deg. Fah.

Precast reinforced concrete columns and bearer beams are used to support the asbestos cement packs, which were made up on site. At the perimeter of the tower is a ring of radial sheets, but the remainder are set in a series of rectangular packs and carry the spray pipes, which are fitted on small precast bearers. The spray pipes are fitted with a series of distributor heads spaced at approximately 2ft 6in centres. Above them asbestos cement eliminator slats, made from a single 6in corrugation, are fitted into a series of splayed castellations on the side faces of the upper beams. The function of these eliminators is to prevent small water droplets from being carried up and out of the tower, and keep water losses to a minimum.

Two stages in the building of the packs are illustrated here. One picture shows part of the complete pack with the sprayer pipes in position, but before the sprayer nozzles have been fitted and before the eliminator slats have been placed in position in the castellations in the upper beams.

The sheets were delivered to the site in bulk and were stacked temporarily in the catchment pond below the tower before being hoisted up to the lower part of the tower shell ready for assembling into packs as illustrated. Transport, handling and packing of the sheets was carried out to a schedule which enabled six fixers to pack more than 100 tons a week, the breakages on site being only 0·25 per cent, which was considerably less than was anticipated. With experience as the work progressed the fixers were able to raise the packing rate to 140 tons a week.

Alternative arrangements of packing are likely to be tried in further experiments with asbestos-cement sheeting.

[Reply Card No. 1081]

Flexible Insulation for Pipes

A NEW, improved pipe insulation material specially designed to reduce installation costs on hot, cold and low-pressure steam piping is now being marketed by Semtex, Ltd., 19-20, Berners Street, London, W.1.

Lightweight, durable and extremely flexible, "Foamflex" is available in lengths of 9ft 9in. It is off-white in colour and is made in sizes to fit pipes of the following nominal cores to comply with B.S.1387 : 1957 ; ⅜in, ½in, ¾in, 1in, 1¼in, 1½in, 2in, 2½in, 3in, 3½in, 4in.

The depth of cover complies with the requirements of B.S.1334 : 1959.

Because of its flexibility, "Foamflex" can be fitted both quickly and easily. The sections are supplied slit longitudinally down one side, and are slipped over the pipe ; the joints are sealed with a special adhesive which is available in quantities from ½ pint to 5 gallons.

The flexibility of the insulation enables it to be carried around large bends, and the material is easily cut to fit bends with sharp internal radii, "T" junctions, &c. No special fittings are necessary.

Overpainting is not necessary under conditions of normal hot and cold working. Unslit sections are available if required.

Performance data :

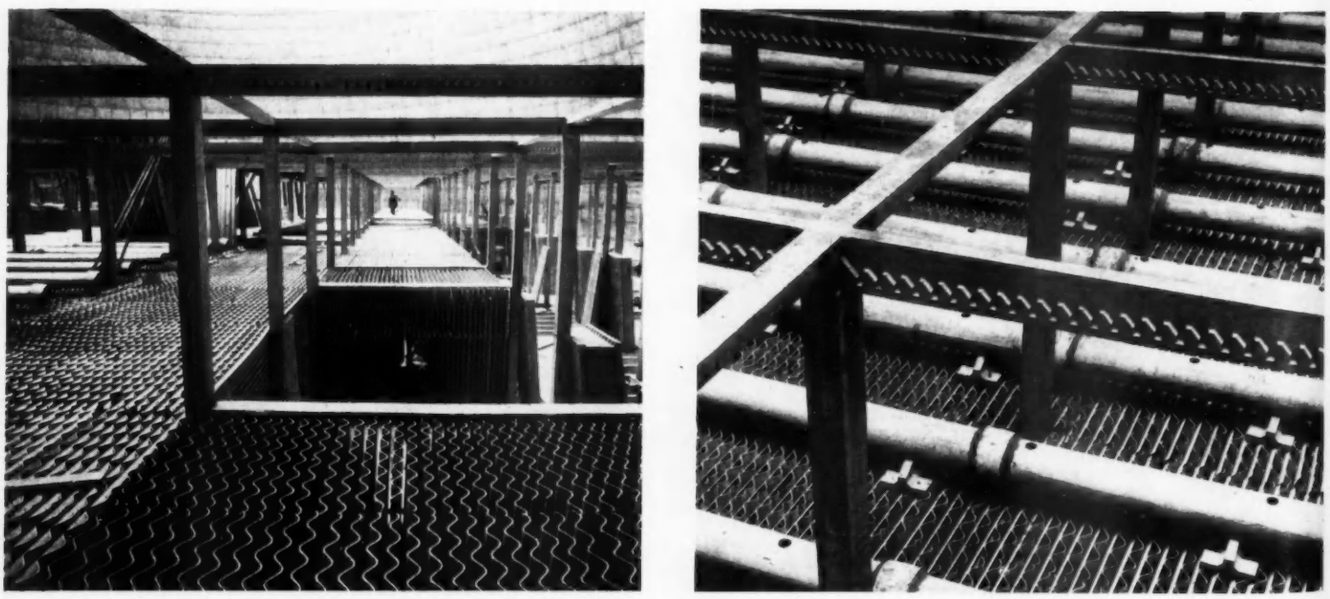
Thermal conductivity—0·22 B.Th.U./square foot/hour/deg. Fah./in at a mean temperature of 70 deg. Fah.
Operating temperatures—Maximum 130 deg. Cent., minimum —50 deg. Cent.
Water absorption (twenty-four hours)—0·59 per cent by volume.
Air transmission—0·73 cubic feet/hour/square foot at 10in Hg/in static pressure.
Fire rating—Self extinguishing.
Chemical resistance—Resistant to dilute acids, alkalies and salt solutions.
Vermin resistance—Good.

[Reply Card No. 1077]

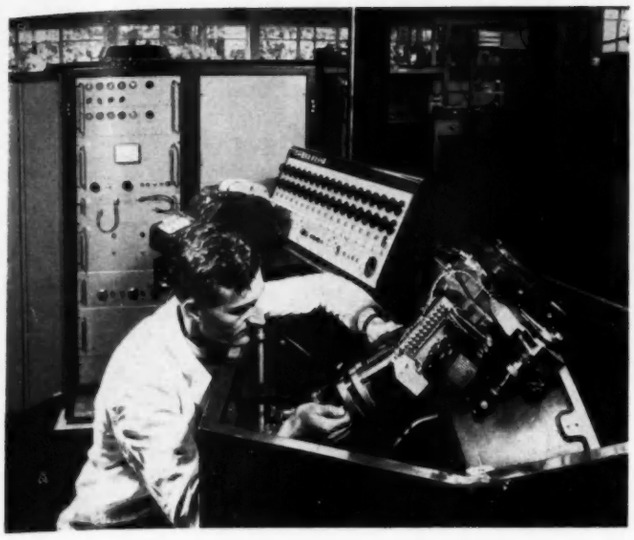
The Fréjus Disaster

IT is reported that Monsieur Jean Dargeau was charged last week with manslaughter by a French magistrate. Monsieur Dargeau, as chief engineer of the Rural Services Department of the French Ministry of Agriculture, held overall responsibility for design and execution of the water supply scheme of which Malpasset dam formed a major element. The failure of the dam, which caused the loss of over 400 lives, occurred in December, 1959. It is reported that there may be other charges too.

The failure was reported in THE ENGINEER of December 11, 1959. A preliminary technical report on the failure, which was ascribed to a rupture of rock below the left bank abutment, was published in THE ENGINEER of May 13, 1960. Further investigations were suggested in the preliminary report. Apparently these investigations and a final report incorporating their results have been completed by the commission of inquiry, but remain confidential at present because of the legal proceedings which are pending.



(Left)—Interior of cooling tower at Padiham "B" power station, showing the reinforced concrete columns and bearer beams and the fitting of the asbestos cement cooling packs. (Right)—The spray pipes are supported by small cast concrete bearers resting direct on the asbestos cement sheeting. The photograph was taken before the spray nozzles and eliminator slats were fitted, and also shows the arrangement of the packing



Electronic cubicle (background), control console and spectrometer of installation for automatic analysis by X-ray fluorescence

Fluorescent X-ray Spectrometer

An applications laboratory for demonstrating the X-ray fluorescent method of analysis, and preparing reports on samples, has been set up by the Solartron Electronic Group, Ltd., at Stornoway House, Cleveland Row, London, S.W.1. The laboratory is equipped with the Solartron XZ-1030 X-ray fluorescent automatic vacuum spectrometer, which detects and determines all elements of greater atomic number than 12. The X-ray fluorescent method is stated to be particularly accurate in the determination of the higher percentage elements, such as nickels and chromium in high alloy steels, and is non-destructive. In the Solartron instrument two specimens are irradiated simultaneously, one being the test sample and the other a reference sample. Rigorous machining of samples is not required. At each position of the spectrometer crystal, the monitor channel is examining exactly the same region of the spectrum as the test channel. Counting on the test channel takes place for the length of time required to accumulate a set number of counts on the standard channel, and thus any tube output variation, either of intensity or spectral distribution, is allowed for, and some simplification of the power supply stabilisation requirements is possible.

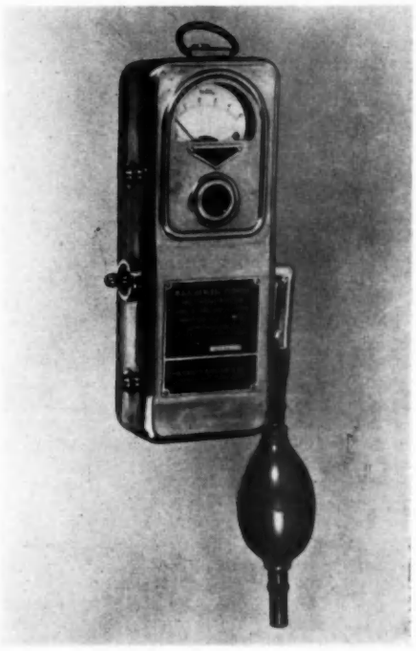
The spectrometer is set up by means of dials on the control console to take up a series of positions at which the peaks of the various elements are known to be located. Each angle is located in turn, the count taken, and the number printed out, after which the instrument traverses automatically to the next angle. If required, the control programme can be set up by punched cards as a further step in simplifying the procedure so that analysis can be carried out by unskilled labour. Results are printed out on a chart showing the number of counts per channel, and these are converted to percentages by reference to calibration curves supplied with the instrument. A complete equipment comprises an electronic cubicle, control console and printer, and a power unit providing 40mA at 50kV for the X-ray tube.

[Reply Card No. 1079]

Firedamp Detector

A portable instrument for the detection of methane in mine air made by Mine Safety Appliances Company, Ltd., of Glasgow, has been approved by the Ministry of Power. This self-contained, non-automatic, general purpose methanometer has a range of 0-5 per cent methane, its meter scale being in 0·2 per cent divisions. It is easy to operate, and in use a button on the front of the case is depressed while a sample of the air to be tested is passed through by operation of an aspirator bulb.

The filaments used in the instrument, which are stated to be very stable, are of a type developed by the Safety in Mines Research Establishment. The flow-system and electrical circuit, with the exception of the calibration resistance, are encapsuled in an epoxy resin contained in a nylon moulding. Another nylon moulding forms the battery container, and the indicating meter is



Portable general purpose methanometer

separately mounted on rubber. The instrument is powered by two Mallory mercury cells, with a capacity of 14,000mAh and at least 6000 tests can be made with one set of batteries under normal working conditions. The state of the batteries can be checked by depressing the meter button and closing a micro switch situated in a recess at the back of the instrument. The instrument is self-zeroing and self-compensating for changes in battery voltage over the operating range and normal changes in atmospheric pressure, temperature or humidity have no effect upon accuracy of the readings.

Special provision has been made for using the methanometer with a sampling probe—an accessory designed for obtaining samples from roof level in high roadways or other inaccessible places.

[Reply Card. No. 1061]

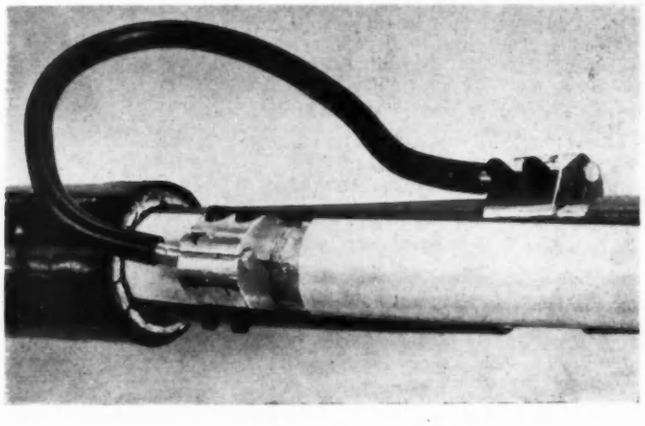
Clip-on Service Connection for Solid Cable

In order to simplify the making of house-service connections to multicore insulated power cables, a clip-on connection clamp for "Solidal" cable has been developed by Aluminium Laboratories, Ltd., Banbury, Oxfordshire. "Solidal" cable is plastic insulated and has solid sector-shaped aluminium conductors. The new clamp is formed of two pieces of extruded aluminium section held together by high tensile steel screws. When screwed together the two halves grip both the solid segmental conductor and the service conductor. Efficient contact is obtained without complete encirclement of the conductor, so that only slight separation of the cores, up to about $\frac{1}{4}$in, is necessary. This is in itself an advantage, since it permits reductions in the size of joint boxes.

We illustrate two of the clamps undergoing load cycling tests at Aluminium Laboratories, Ltd., showing a length of service cable connected to two cores of a "Solidal" cable which have been separated as described. Through loops formed in this way, current was passed to give a maximum conductor temperature of 80 deg. Cent. This maximum value was selected as being sufficiently in excess of the present specification maximum of 70 deg. Cent. allowed with P.V.C. insulated cables, to provide realistic test conditions. Specimens have been subjected to about 10,000 cycles of half-hour heating and half-hour cooling; resistance measurements taken at intervals throughout the tests showed that the joints were electrically stable. The tests were carried out on clip-on clamps applied to two intermediate sizes of "Solidal" cable, and have been followed by similar tests on 400A (0·471 square inch) cable.

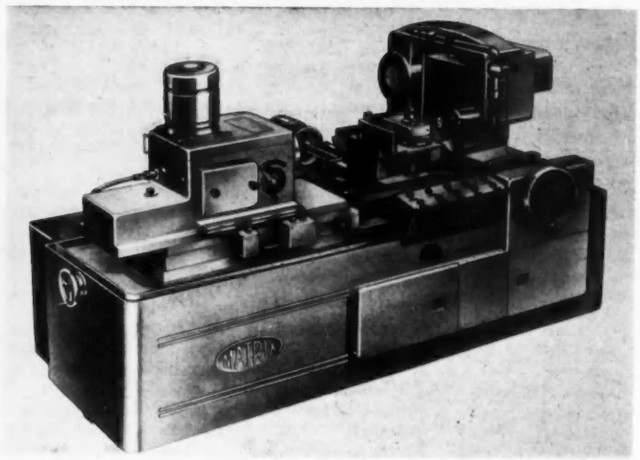
Simulated short-circuit tests have been conducted by the E.R.A. on a series of clamps fitted to an intermediate size of "Solidal" cable. In one instance a short-circuit current of 10·7kA for 0·09 seconds melted the service conductor, yet the joint remained stable, the resistance between the main and service conductors increasing from 36·1 microhms to 37·2 microhms. A number of trial house-services using clip-on clamps have been installed by Area Boards in this country and by European utilities, and improvements in connection time have been achieved. The clamps are being manufactured commercially by Erma, Ltd., Mount Pleasant, Alperton, Middlesex.

[Reply Card No. 1076]



Test loop attached to solid core cable by clip-on connections

SHORTER REPORTS *(Continued)*



Grinding machine for internal threads up to 10in diameter

Internal Thread Grinding Machine

A NEW internal thread grinding machine has been designed by the Coventry Gauge and Tool Company, Ltd., Fletchamstead Highway, Coventry, for the accurate grinding, on a quantity production basis, of a wide range of nuts and half nuts of ball track and other forms. The machine, to be seen in our illustration with its covers removed, handles workpieces with a maximum diameter of 13in and grinds threads up to 10in diameter.

The machine is fully automatic in operation apart from loading and unloading components. The single ribbed grinding wheel of 3in maximum diameter which is used is automatically diamond dressed at preselected intervals. Single pass or multi-pass grinding can be carried out, the maximum number of passes being twenty-four, and the total automatic wheel infeed available is ¼in.

On full nuts the grinding action is continuous, wheel infeed taking place at each work slide reversal. When grinding half nuts the wheel feeds into the stationary workpiece to the preset depth, the work spindle then revolves and the workslide traverses. At the end of the traverse the wheel retracts clear of the work and the workslide returns. To permit easy loading and unloading the wheelhead is automatically retracted to its rear position when a workpiece is finish ground.

Two types of grinding wheel spindles are available for this machine—belt-driven or high frequency. The belt-driven spindle is driven by a 5 h.p. motor and it has speeds of 15,000 r.p.m. and 18,000 r.p.m. The high-frequency spindle has steplessly variable speeds from 12,500 r.p.m. to 40,000 r.p.m. A swivelling movement is provided for the wheelhead unit to accept right- and left-hand threads with helix angles up to 15 deg. to be ground. The normal maximum thread length which can be ground is 5in and it can be increased to 7in with a special wheelhead design, although this limits the maximum helix angle to 10 deg. The diamond dressing unit is mounted on a swivelling cradle so that the wheel can be accurately formed with the wheelhead inclined at the helix angle of the thread being ground. Wheel dressing can be effected before or after the final grinding pass.

The workhead is driven by a 1½/3 h.p. motor providing seven spindle speeds of 6-105 r.p.m. and 12-210 r.p.m. The pitch of the thread ground is determined by interchangeable leader bars and nuts, the same bars and nuts being used for right and left-hand threads of identical pitch. The workhead is mounted on a sub-slide and it can be positioned longitudinally relative to the grinding wheel to facilitate the grinding of short threads in long components. The workhead spindle, which has a 2in bore, can be indexed for two, three, four, five and six start threads. Means of adjustment to control parallelism is provided and there is a side cut control for aligning a preroughed thread with the grinding wheel. Coolant is delivered through the workhead spindle and externally to the grinding wheel, a delivery pipe also being provided at the wheel dressing position.

[Reply Card No. 1062]

Automatic Analysis of Steel

WE illustrate the installation of photomultiplier tubes in the twelve-channel polychromator of the "Polyvac-12" unit introduced recently for the automatic analysis of steel by Hilger and Watts, Ltd., 98, St. Pancras Way, Camden Road, London, N.W.1. This direct-reading vacuum spectrograph is able to determine eleven elements in a steel sample in less than three minutes and presents results on a meter, recorder or typewriter.

The prepared sample is clamped to the discharge stand of the spectrograph, where a discharge takes place in argon. Light from the sparked sample passes through a "Spectrosil" condensing lens into the vacuum chamber, and after traversing the slit and the collimator lens is turned through nearly 90 deg. by two prisms. This dispersing system covers a wavelength region in which all the elements necessary to steelmaking have good spectral lines. High resolution is provided by the fluorite lenses. The sparking of the sample in argon and the housing of the dispersing system in a vacuum prevent the absorption by oxygen of radiation in the far ultra-violet region.

The dispersed beam then passes through the camera lens and is brought to a focus along the focal curve, where the desired wavelengths are selected by the exit slits. Each selected ray is reflected by a plane mirror to a slit lens, which focuses it on to the cathode of one of the photomultiplier tubes. These were supplied by E.M.I. Electronics, Ltd., Hayes, Middlesex, to meet a specification calling for high stability and a very low dark current. The photomultiplier outputs are stored by means of capacitors in the integrator unit of the electronic console. A measuring unit measures each capacitor charge in turn and presents the results on a meter or recorder, or through a comparator to an automatic typewriter.

In the comparator the potentials of the integrating capacitors are compared with a reference potential built up by a series of internally-generated pulses. These are counted up to coincidence and used to control the typewriter. If, however, the standard 5in microammeter is used for read-out, the values obtained are referred to the working curves for concentration percentages.

[Reply Card No. 1059]

Seventh Congress on Large Dams

DURING last week the seventh international congress on large dams (which is organised by the International Commission on Large Dams of the World Power Conference) was in progress in Rome. This week, delegates will have been travelling on one or other of the various post-congress tours which customarily follow the conference itself.

Technical activity of all kinds in this field remains as brisk as ever, and the papers presented at the seventh congress maintain the exacting standards of previous congresses, both in bulk and in erudition. As customarily, the bulk of the technical contributions are grouped under subject headings or "questions" as they are termed, but a few papers not classified in this way have been submitted as "communications." The four "questions" before the seventh congress were as follows: question No. 24, the selection, processing and specification of aggregates for concrete for large dams; question 25, underground works in connection with design and construction of large dams; question 26, modern techniques for concrete dams for wide valleys, and ancillary works; question 27, sealing earth and rockfill dams with bitumen and other materials. The conference papers also included a further report from the international sub-committee on concrete for large dams. About sixty British delegates attended the conference.

Installing photomultiplier tubes in the twelve-channel polychromator of a direct-reading vacuum spectrograph

Teleprinter Transmission on Speech Circuits

FULLY transistorised frequency-modulated telegraph equipment to convert teleprinter or data intelligence into voice frequency signals and transmit the signal over telegraph circuits has been developed by Associated Electrical Industries, Ltd., Crown House, Aldwych, London, W.C.2. The equipment, made by A.E.I. Telecommunications Division, can send and receive information via a maximum of twenty-four telegraph channels over any four-wire bearer circuit capable of transmitting the frequency range 300 to 3300 c/s and having a performance conforming to C.C.I.T.T. recommendations for an international speech circuit.

Teleprinter or data information is usually encoded as positive or negative pulses of direct current, which are not suitable for transmission over lines or radio links where audio-frequency amplification equipment may intervene. It is therefore necessary to translate the d.c. pulses into corresponding pulses of a.c. at voice frequency, and back into d.c. at the receiving end. The polarity of the d.c. pulse can be imposed on the voice frequency signal either by amplitude or frequency modulation. A frequency-modulated voice frequency telegraph (FMVFT) system is particularly suited to the transmission of telegraph messages on circuits which have an inherent high noise level, such as long lines, radio links, or even submarine cables where the available band width must be fully exploited. However, its use has tended to be confined to a relatively small number of circuits in a few national networks, on account of greater terminal cost and complexity. The present type CT24A equipment has been designed to overcome these disadvantages as far as possible. The complete equipment with power supplies can be mounted in a standard 19in rack 9ft high. Plug-in units using printed circuit wiring boards and small encapsulated filter and transformer units are employed so that servicing can then take place on a test bench, away from the rack, after a spare unit has been plugged in. The construction of the tone sender unit is illustrated.

Operating speed is normally 50 bauds, but operation up to 80 bauds is possible if a slight increase in the telegraph distortion can be tolerated. A pilot channel can be provided with the system for insertion at either 300 or 3300 c/s which will correct for frequency asynchronism of the bearer circuit carrying the twenty-four telegraph channels, where the bearer circuit is itself frequency-multiplexed. Visual alarms operate in the event of power supply failure and for a fall of more than 10 dB in the received pilot level. The d.c. telegraph output can be derived either from a high-speed polarised relay or a transistor switch. At present a relay unit is employed. A relay and telegraph test set, a level measuring set, and a frequency check unit can be mounted on the terminal rack.

The rack framework is prewired and station cable runs are brought in at the top of the rack and terminated at tag strips running down the sides. Prewired mounting cases containing socket assemblies and side tag strips are fitted into the framework. Electrical connections between the rack wiring and the mounting case wiring are made by short parallel soldered straps. The mounting case is equipped with plug-in units according to the requirements of the installation, and these are retained in position by screw type fasteners.

The equipment is operated from a 12-0-12V d.c. stabilised source, provided by rack-mounted power units energised from 100V–120V or 200V–240V a.c. mains. Power consumption for a fully equipped rackside of twenty-four channels is approximately 50W. A mains-operated telegraph battery 80-0-80V supply can also be fitted to the rack and will supply up to 25mA per channel for a total of twenty-four channels.

[Reply Card No. 1071]

Modular storage system which, using standard units, can be varied in size and capacity and quickly regrouped to suit different conditions

Flexible Storage System

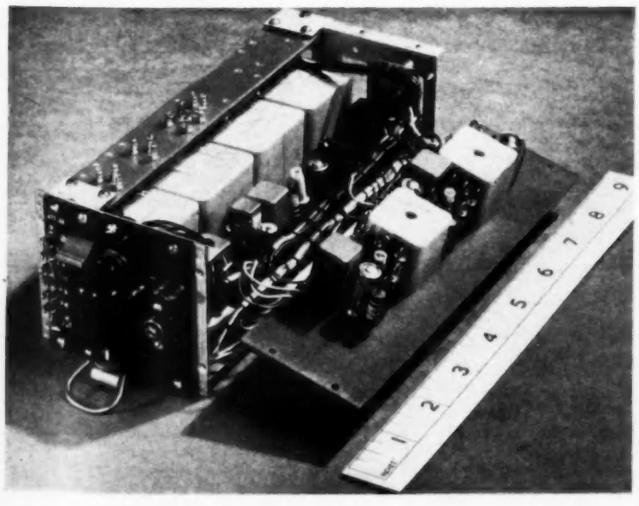
A MODULAR storage system recently introduced under the trade name of "Spacesaver" by Bradley and Co., Ltd., Albion Works, Bilston, Staffs, can—by the use of standard drawer type containers, shelving and other accessories—be easily installed and its capacity increased as required by the introduction of additional units to the sides, top and rear. No tools are required in assembling the shelving and it can quickly and easily be dismantled and rearranged when regrouping is necessary. A typical block of stores shelving built on this system can be seen in our illustration.

The drawers or containers used are made in five standard sizes with nominal lengths of 13in, 19in and 25in and widths of 9in, 12in and 18in, all having a standard depth of 8in. These containers are made up of 20 gauge spot-welded steel sheet deeply embossed to impart rigidity, and their design allow their use as work containers for normal component transport between machines in shop production lines. They are self-stacking and are available heavily galvanised or with a stove enamelled finish in various colours. An inclined front panel, which has an identification slip holder, facilitates discharge of parts, and a support bar at the top at the front and rear of each container gives ease in handling.

The shelving is built up from basic frame units which can be stacked one on top of the other and have anchor brackets at the corners to provide stability as height is increased. Full access is available across the width of the shelving so that containers can be stored in both front and rear. The heights of the intermediate container platforms in the shelving can be adjusted, and where a block of shelves requires to be extended economy is effected by the use of "bridging" shelves between pairs of standard units. These "bridging" shelves are supported by clips which fit into slots in the vertical members of the units.

By the fitting of four castors to the foot of the upright members and the addition of a cover, a standard shelf unit can be easily converted into a trolley for containers—two such trollies can be seen in use in our illustration. The top members of the shelf units are a sufficient height above the standard containers and their strength is such that they can be handled by a fork-lift truck when necessary.

[Reply Card No. 1068]



Tone sender unit of frequency-modulated system for teleprinter and data signal transmission over lines with a.f. amplification

Moisture Measuring Unit

A MOISTURE measuring unit for use in the paper, textile, food, tobacco and other industries is announced by Honeywell Controls, Ltd., Greenford, Middlesex. Moisture content is controlled by detecting changes in resistance of the product as it passes between two conductive surfaces—for example, between a machine roller and a detector roller, or a metal chute and a probe. The detecting element of this "Moist-O-Graph" system is connected by low-loss cable to a 0 to 10 millivolt transmitter, the output of which can be fed into any compatible instrument for indication, recording, control or re-transmission. In a typical textile application, the system would control the moisture content in the warp yarn either by variable speed, constant temperature/pressure, or constant speed, variable temperature/pressure control. For paper making, a pneumatic cascade moisture control system would permit presetting of a desired reduction of pressure or temperature automatically each time the machine stopped. It is claimed that moisture contents above 40 per cent can be controlled in paper applications.

[Reply Card No. 1075]

SHORTER REPORTS *(Continued)*

Innovation in Vibration Testing

DOWTY-ROTOL, Ltd., will soon have available an entirely new apparatus for carrying out high-load vibration tests, based upon an application of electro-hydraulics.

Its evolution began as a demonstration of the Dowty Moog servo valve's high-frequency capabilities at the S.B.A.C. Show at Farnborough last year. The demonstration rig reproduced speech and music via the servo valve and hydraulic jack operating a diaphragm. Afterwards it was realised that if it was possible to produce such high frequencies and such a wide range of amplitudes, then the principles involved could be adapted to the requirements of high-load testing in industry.

Towards the end of March this year this new Dowty Rotol Power Vibrator successfully completed acceptance tests at Arle Court, Cheltenham ; details of these tests are tabulated.

It is now apparent that almost anything which in a service is subjected to great variations in loading or to widely varying strains and stresses can be thoroughly tested by this new hydraulic apparatus. It is ideal for high-frequency fatigue testing or, alternatively, it can be used for vibration tests on a missile or any other structure, such as a suspension bridge which has to carry erratic streams of traffic.

Hydraulic vibrator

Two considerable virtues will commend it to manufacturers : its compactness and its comparative cheapness. It has been estimated that it will cost perhaps only a quarter of what is usually involved in operating testing devices worked by electro-magnetic means.

The Dutch Technical Institute at Delft has used such equipment for carrying out a resonance search on a dam ; another set has been supplied to the Cape Engineering Company, Warwick, for carrying out fatigue tests on materials.

There is a perfected design (illustrated), now on the drawing board at Arle Court, which incorporates lessons learned from practical experiments to date. It is expected that apparatus to this new design will be available by September. It will stand barely 3ft high and will include provision for a table to which a variety of items can be clamped for undergoing shaking tests.

This apparatus will be able to operate for fatigue testing at frequencies up to 500 c/s, superimposing cyclic load on a steady load, both applied through a hydraulic jack, fed by the high-frequency response servo valve. An oscillator determines the frequency at which this servo valve functions.

At 45 cycles, the vibrator imposes the required 25,000 lb load and allows the load to be cycled between 15,000 lb and 35,000 lb. At 17 c/s, the load can be cycled between 5000 lb and 45,000 lb.

For tests in vibration, such as in missiles, the load can be held to plus or minus 1000 lb up to 200 c/s and to plus or minus 250 lb up to 500 c/s. Given extra hydraulic power the range of vibration can be considerably extended.

In the acoustic range it would seem that valuable possibilities could be opened up. All the different noises set up by vibrations in an aircraft at various altitudes, in a ship under varying conditions at sea, or in a submarine at different depths could be recorded upon tape which could be played back later for laboratory tests.

TABLE—*Performance of Prototype*

(1) A mean load of 25,000 lb cycling between load levels of 15,000 lb and 35,000 lb. Load levels to be held to ±2 per cent. The rig to be capable of applying the above cyclic loading at 45 c/s ± 5 per cent at an amplitude of 0·030in (peak to peak).

(2) A mean load of 25,000 lb cycling between load levels of 5000 lb and 45,000 lb. Load levels to be held to ±2 per cent. Frequency of loading 17 c/s ± 5 per cent at an amplitude of 0·060in (peak to peak).

(3) A mean load of 25,000 lb cycling between load levels of 0 and 50,000 lb. Load levels to be held to ±2 per cent. Frequency of loading 9 c/s ± 5 per cent at an amplitude of 0·100in (peak to peak).

Ballast Cleaning Machine

WE illustrate a self-propelled six-foot and shoulder rail track ballast cleaning vehicle which has been built by the Hunslet Engine Company, Ltd., Leeds, for the North Eastern Region of British Railways. It is designed to clean only the ballast in the track shoulder and six-foot and not underneath the track as, it is stated, the provision of clean ballast at both ends of the sleepers permits drainage of rain water throughout the road bed to cleanse the centre section. The machine is self propelled and has a maximum working speed of 600 yards an hour at which it can deal with 300 tons of stone ballast. When the track shoulder only is being cleaned free passage is afforded to trains on the adjacent road of a double track line.

The vehicle is powered by a Rolls-Royce diesel engine developing 208 b.h.p. at 1800 r.p.m. driving four "Deri-Sine" duplex hydraulic pumps through a toothed belt and Hunslet gearbox. These pumps supply pressure fluid to the hydraulic motors used to drive all the operating units on the machine. Two digging heads, one on each side of the machine, are pivoted in frames in which they are retracted into the body of the vehicle by hydraulic rams for travelling purposes. Individual controls are provided for the speed of digging, depth of cut, &c., on each head, the digging belts of which are fitted with renewable hardened steel picks or tines and are driven by hydraulic motors.

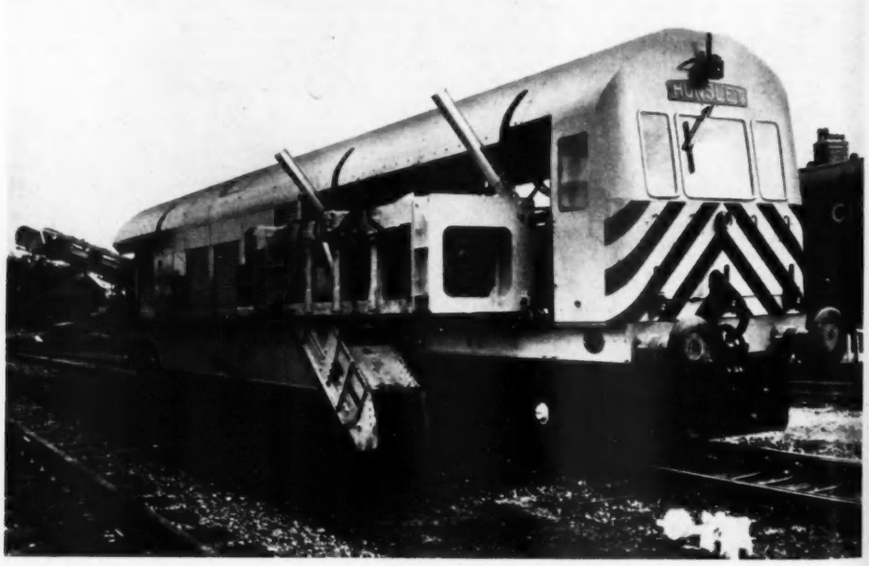
Ballast is raised on the digging belts and deposited on conveyors which transfer it to screens in the body of the vehicle. The double deck vibrating screens have mesh for 2in-$\frac{3}{4}$in ballast and they are divided by a centre plate to provide independent screening for the left- and right-hand digging heads. Cleansed ballast leaving the screens gravitates to chutes on each side of the vehicle and is returned to the track. A disposal conveyor beneath the screens carries the dirt to a second conveyor which can be extended beyond the end of the vehicle. This second conveyor is rotatably mounted so that it can deposit the soil rearwards into a trailing wagon or to either side of the track.

The equipment is mounted on a fabricated plate girder frame with two bogies built up of standard B.R. components. One axle of the leading bogie is driven by an 80 h.p. hydraulic motor through a two-speed, epicyclic gearbox. Hydraulically operated braking is applied on all wheels of the vehicle and a screw handbrake operates on the four wheels of the leading bogie.

Silicon Devices

AN addition to the RS series of medium and high-power silicon rectifiers is announced by the Components Group of Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2. Designated RS600, these new devices are rated at 25A mean, and 100V to 600V crest working voltage at 125 deg. Cent. maximum stud temperature. Maximum dissipation is 30W. These rectifiers are available either stud positive or stud negative, and heat sinks to give full rating with natural air cooling at ambients up to 40 deg. Cent. can be supplied. The group has also introduced a " SenTerCel " Zener reference diode capable of dissipating 7½W when used with an appropriate heat sink. The range from 6·8V to 50V is covered with 5 per cent tolerance. These silicon Zener diodes have a maximum operating stud temperature of 125 deg. Cent., allowing minimum heat sink size.

[Reply Card No. 1070]



One side of ballast cleaning machine, showing digging head lowered to its operative position and the disposal conveyor at the rear swung out to deliver dirt at the side of the track

Long Rail Handling Train for London Transport

THERE has just been placed in service by London Transport a specially-constructed train for handling the 300ft long welded rails. The train incorporates a power winch equipment which enables 300ft rails to be reloaded on to the train from the track. Past practice, when removing 300ft rails from the track, has been to cut them up and load them piecemeal, but the new facilities for reloading them in their full lengths means that the rails can now often be relaid at other sites to give a further period of service. The train will carry up to eighteen such rails, weighing some 90 tons, and the rails are carried at an unusually low level, making loading and unloading easier to carry out. The wagons were built by the Gloucester Railway Carriage and Wagon Company, Ltd. to London Transport designs. The underframes, bogies and Westinghouse brake systems are similar to those on existing 20-ton rail-carrying wagons, but the rail-carrying bolster equipment is of new design.

The full load of rails is carried in three tiers, the bottom tier being supported 4in above the deck plates by triangular bolsters, at 8ft 4in centres, bolted to the deck of the wagons, and the second and third tiers are supported by loose bolsters of similar shape. Nigger bars of heavy channel section are bolted to the solebars of the wagons at each deck bolster position. The loose bolsters between the tiers of rails are connected by locking pins so that the rail load is held together as it moves freely across the fixed deck bolsters on curved track.

Apart from these fixed and loose bolsters there are pinned bolsters for holding the rails in position laterally and symmetrically about the centre line of the train. These pinned bolsters are arranged on the wagons in relation to each king pin position so as to produce a force sufficient to overcome the friction between the rail load and the fixed deck bolsters and thus bring the rails back into line when the train passes from curved to straight track. A clamping bar positioned on the centre wagon of the train clamps the rail load at approximately the centre of the rail span. This is the only position at which the load is secured on the train, there being no chains at the rail ends, which are free to move longitudinally in transit. The emphasis throughout the design of the bolster equipment was on the flexibility of the rail load, reducing as far as possible the lateral thrust on the bolsters, wagon underframes and bogies, so keeping axle stress to a minimum.

Loading of rails from the track is carried out with the use of an 8 h.p. electric winch, built by Clarke, Chapman and Co., Ltd. of Gateshead. The winch is fixed to a rigid platform of steel plate fitted on the trailing end of the last wagon of the train.

The power supply for the winch is taken from the auxiliary circuit of a battery locomotive used to haul the train, and four battery locomotives have been adapted for this work. The winch has two independent barrels for lifting and loading at either side of the negative (central) conductor rail and it can lift a load of 3 tons at 27½ft per minute.

To load a long rail from the track, the train is positioned with the winch wagon at one end of the rail. A roller with a hinged frame is then swung into position over the wagon headstock, and after the rail end has been lifted up and placed on the roller by the winch, the winch rope is disconnected and a special guide roller attachment slipped on to the rail end. The train is then propelled under the rail, pushing the rail against a stop which is attached to a sleeper at the opposite end of the rail, until approximately the last 20ft of rail is overhanging the roller. The train is then stopped and, using the winch, the remainder of the rail is pulled on to the train. The guide roller attachment lifts the rail end gently over the deck bolsters and, on curved track, guides the rail sideways by roller contact with a heavy longitudinal channel held in position by the nigger bar channels. The time taken to load a 300ft rail is 8 minutes, and rails can be loaded either singly or in pairs.

Rails can be off-loaded by the normal process of securing one end to a suitable point on the track and moving the train away so that the rail is drawn off over one of the headstock rollers. Off-loading can be carried out from either end of the train.

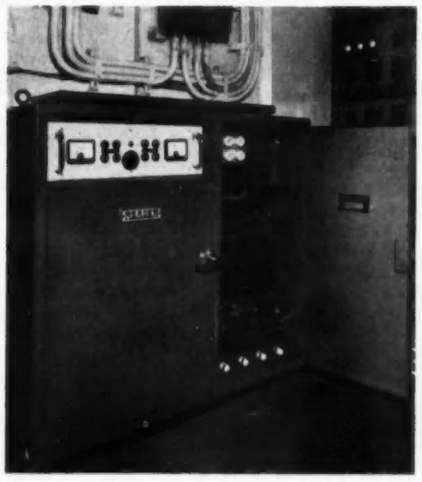
Conductor rail end being lifted on to headstock roller by the winch

Cathodic Protection for Ships of all Sizes

IT is well known that the corrosion of metal in sea-water is due to an electro-chemical reaction, and that it can be stopped by changing the electrical potential of the metal. Some success has been achieved by the use of cathodic protection with what are known as " sacrificial " anodes, but this system has its limitations, notably the fact that the current generated is almost constant, whereas the actual current requirement varies according to local conditions such as water salinity, ship's speed and the condition of the hull paint. Excessive current can cause damage to the paint ; insufficient current fails to afford proper protection. A better way to provide protection is to use an external current supply, taken from the ship's electrical equipment, and vary it according to need at any particular time. It is this system, using non-sacrificial anodes, on which E. Reader and Sons, Ltd., Phoenix Engine Works, Cremorne Street, Nottingham, has based its range of equipment, which, in three standard forms, is now available for any type and size of ship.

For large ships the " Readermatic " system is supplied. This, as its name implies, is fully automatic in operation, varying the current to suit changing conditions in salinity, speed, temperature or hull paint. The current flows through anodes of ennobled lead alloy of streamlined form attached to the hull. Reference electrodes of zinc are also attached to the hull, and these give a signal representing the hull potential to the automatic controller housed in a convenient place in-board. The amplifier output controls a saturable reactor, the output of which is fed to a transformer rectifier. On normal operations the hull potential is thus held to the desired figure within a few millivolts. On ships with an a.c. supply of 110V or more the " Readermatic " equipment is connected directly to the supply. If the supply is d.c. a small motor generator is used to provide a.c. for the protection equipment.

Smaller ships such as coasters and trawlers operate, in the main, on a more regular routine than the large ocean-going vessels, and protection requirements are more easily predictable.



On larger ships an automatic controller varies the current according to local conditions

For such ships a simpler form of equipment, the " Readermajor," is marketed. This has a simple manual control which enables the current to be set according to conditions indicated by a control panel. A variant of the " Readermajor " caters for ships which may spend relatively long periods in harbour, with no current available. In such cases the equipment operates with sacrificial anodes while the ship is idle, and with generated current when it is at sea.

A still smaller set of equipment, the " Readerminor," is made for small craft, including yachts and fishing boats. It is adaptable for rudder and propellor protection alone on vessels with wooden or other non-metallic hulls. The equipment takes its current from the vessel's battery, and the consumption is only a few milliamps in harbour. A feature of the " Readerminor " is its simplicity, which enables it to be fitted by any electrician or by a knowledgeable amateur.

[Reply Card No. 1063]

Helical P.D.A. Tube

A FIVE-INCH diameter double-gun helical p.d.a. tube, corresponding to the existing 3½in 900E, has been added to the range of the M-O Valve Company, Ltd., Brook Green, Hammersmith, London, W.6. The new tube, 1300F, is for use in general-purpose oscilloscopes where two independent signals are displayed on a common timebase, and incorporates post-deflection acceleration to give increased brightness and sensitivity. Deflection sensitivity in the x direction is 20V/cm and in the y direction 12·5V/cm with a gun voltage of 1·2kV and a final anode potential of 4kV. The line width is approximately 0·5mm. The minimum useful scan in the horizontal direction is 10cm but in the vertical direction the common window is 7·5cm. Side-pin connections to the deflector plates contribute to low input capacitance. Overall length, excluding base pins, is 40·5cm ±0·5cm.

[Reply Card No. 1072]

INDUSTRIAL NEWS

Production and Employment

According to a survey published in the current issue of the Treasury's *Bulletin for Industry*, final demand, after changing little during 1960, has been rising in the first half of the present year. Retail sales have moved up, there has been a distinct recovery in domestic car sales, and fixed investment in both the public and private sectors has been rising rapidly. In the opening months of the year there was a sharp reduction in the rate of stockbuilding so that industrial production taken as a whole did not immediately change. There are signs, however, the Treasury says, that more recently production has started to rise again, with the index for March and April, taken together, 1 per cent up on the January/February average and 1 per cent higher than a year earlier.

The rise in both employment and unfilled vacancies has been larger than normal for the first half of the year. Unemployment has fallen more than the normal seasonal movement, and at mid-June the number of people registered as unemployed was down to 1·2 per cent of the estimated number of employees, and labour is now short in many parts of the country. In five regions, the Treasury states, London and the South East, Eastern and Southern, Midland, North Midland and East and West Ridings, unemployment is below 1 per cent. The Northern Region is exceptional at 2 per cent, the Treasury adds, much the same as in Wales. In Scotland, as elsewhere, unemployment has fallen more than usual this year, but at 2·8 per cent is still well above the low national average. Since 1948 the average for the whole country in June has been lower than this year's 1·2 per cent in only four other years—1951, 1954, 1955 and 1956.

Industrial Disputes

Statistics relating to stoppages of work due to industrial disputes in the United Kingdom are published in the current issue of the *Ministry of Labour Gazette*. The number of stoppages beginning in May, 1961, which came to the notice of the Ministry was 236. In addition thirty-six stoppages which began before May were still in progress at the beginning of the month. The approximate number of workers involved during the month at establishments where these 272 stoppages occurred has been estimated at 86,200, this total including 31,900 workers involved in stoppages which had continued from the previous month. Of the 54,300 workers involved in stoppages which began in May, the Ministry says, 51,200 were directly involved and 3100 indirectly involved. The aggregate of 275,000 working days lost during May included 138,000 days lost through stoppages which had continued from the previous month. The number of working days lost in April, 1961, was 339,000, and in May, 1960, 422,000.

Of the 272 stoppages occurring in May the coal-mining industry was responsible for 133, the number of workers involved being 14,800 and the number of working days lost 31,000. In the engineering industry, the number of stoppages was thirty, workers involved 16,600 and days lost 30,000. Although there were only seven stoppages involving some 6100 workers in the motor vehicle industry in May, the number of working days lost was 36,000. In the Port and Inland Water Transport group also, there were only six stoppages involving about 15,600 workers, but some 44,000 working days were lost.

Wages and Hours of Work

Up-to-date particulars about minimum or standard rates of wages and of the length of the normal working week in more than 200 industries and services in the United Kingdom are given in the fifteenth edition of *Time Rates of Wages and Hours of Work*, compiled by the Ministry of Labour, which has just been published (H.M. Stationery Office, price 16s.).

The new edition, a revision of the 1960 volume, has nearly 300 tables giving summaries of the main provisions of voluntary collective agreements between organisations of employers and workpeople, or made by Joint Industrial Councils or other similar bodies, and also of a number of Statutory Orders under the Wages Councils Acts. In addition to current time rates of wages and hours of work these summaries give particulars, where available, of the basic rates for piece workers, additional rates for shift and night workers, and of arrangements, if any, for a guaranteed weekly wage or period of employment.

Three appendices give details of rates of wages for young workers in a selection of industries, of overtime rates of pay, and of arrangements for paid holidays in the industries and services included in the main tables.

Urban Road Planning

The Ministry of Transport has announced the formation of a "steering group" to study road problems. Some time ago the Ministry announced the appointment of Mr. Colin Buchanan to advise on this problem, and "to undertake a study of the developing problems of roads and traffic in urban areas and their influence on the urban environment." Mr. Buchanan, the Ministry states, will be particularly concerned with the long-term demands for motor transport in towns, the nature and probable cost of the measures required to accommodate such transport and the time required to implement them, and the compatibility of these measures with other needs of towns such as reasonable compactness, economical use of land and good environment. To assist him the Minister of Transport is appointing a steering group of which Sir Geoffrey Crowther will be the chairman, "to keep itself informed of the way in which Mr. Buchanan's work is proceeding, to give him general advice as to the broad lines which he should pursue and to give the Minister their advice on Mr. Buchanan's conclusions." The other members of the steering group will be: Sir William Holford, President, R.I.B.A.; Mr. O. A. Kerensky, partner Messrs. Freeman, Fox and Partners; Mr. C. H. Pollard, city treasurer, Kingston upon Hull; Councillor T. D. Smith, leader of the Labour Group, Newcastle upon Tyne Council; and Mr. Henry Wells, chartered surveyor, chairman Hemel Hempstead Development Corporation.

Report of Delegation Studying Trade with South East Asia

The report of the trade delegation, sponsored by the Board of Trade and the Federation of British Industries, which studied the markets of South East Asia in April this year, has now been published. The delegation was made up of four missions which left London on April 11 for Malaya and Singapore, the Philippines, North Borneo and Sarawak, Thailand and Burma, and Indonesia.

The picture of South East Asia which emerged overwhelmingly from the mission's discussions, the report says, was of a new region with new demands requiring new methods of approach. Too much of British industry was treating South East Asia as an old market with old methods: whilst Britain's long-standing connections with the region were of immense benefit to its trade, they inevitably brought the spirit of "our company has been trading with these countries from father to son for generations and what did for them will do for us to-day." This attitude, the delegations suggests, is the background to all the detailed failings pointed out in the report.

The countries visited have a total population as large as that of the United States or of Western Europe, and although purchasing power of the individual is low, in aggregate it is already substantial, and the purposeful way in which development is being tackled, the report says, leaves little doubt of major growth over the next decades. Several of the countries visited had recently produced new development plans and, the report warns, British firms cannot afford to be even second in involvement in the formative stages of this economic and trading development. Unless Britain made its best effort now, a pattern of trade would emerge without it. If this country's efforts were too little, they would be too late.

In its remarks on the supply of capital goods the report also stresses the need for technical assistance in the countries concerned. British firms will need to co-operate still more closely with their agents in the training of technical personnel. They will need to co-operate more than ever in the setting up of training schools and demonstration centres in the use of the products they wish to sell. Firms will need not simply to install plant, the report adds, but to ensure that it works both by technical and managerial assistance.

Both in the consumer and in the capital goods fields, much was said to the missions about Britain's prices and deliveries. Whilst not overlooking that Britain was inevitably undercut in certain lines by some of its competitors, particularly Japan, the report says that even in such lines there was a sector in which Continental competitors were doing better than Britain. Some of the missions, the report states, heard of the adverse effect on this country's exports to the region of export price fixing arrangements in certain British industries, and as to deliveries, while instances of delays and negligence could be heard round the world, not, however, confined to British suppliers, the cases reported to the missions in South East Asia seemed to be expressions of off-handedness towards those markets.

PERSONAL AND BUSINESS

Appointments

MR. R. W. FLUX, M.I.E.E., has been appointed to the board of Bruce Peebles and Co., Ltd.

MR. JOHN H. PAYN has been appointed publicity officer for the Braithwaite Group of companies.

MR. CHARLES STORR has been appointed northern representative for Landmaster, Ltd. He takes over from Mr. Gordon Still.

MR. J. R. JAMES, deputy chief planner of the Ministry of Housing and Local Government, has been appointed chief planner.

THE PLESSEY COMPANY, Ltd., states that Mr. George A. Smith has been appointed manager of the electronic and equipment group.

BAKER PERKINS GRANBULL, Ltd., has announced the appointment of two directors, Mr. Norman Harwood and Mr. J. S. H. Rodman.

MR. I. M. BAIN, A.M.I.C.E., has been appointed manager of Holland & Hannen and Cubbitts' north east area office at Gateshead-on-Tyne.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces the appointment of Mr. D. I. S. Hinton as sales manager of B.I.C.C.-Burndy, Ltd.

MARCO REFRIGERATORS, Ltd., has announced that Mr. Allan B. M. Simpson and Mr. Norman Herbert Leach have been appointed directors of the company.

MR. E. M. HEAP, joint managing director of York Shipley, Ltd., has been appointed to the board of Le Froid Industrial Briseonneau-York S.A. of Paris.

MR. H. COOPER has been appointed sales manager, telecommunication transmission department, Associated Electrical Industries Telecommunications Division.

CAPTAIN ARTHUR GEORGE PATEY has been appointed to the command of R.M.S. " Transvaal Castle," now being built on Clydebank by John Brown and Co., Ltd.

THE MINISTRY OF POWER announces the appointment of Mr. H. P. Newman as a part-time member of the South Western Gas Board with effect from August 1, 1961.

BTR INDUSTRIES, Ltd., announces the appointment of Mr. G. E. Timms, A.M.I.Mech.E., A.M.I.E.E., as chief engineer of its Silvertown factory, London, E.16.

THE UNITED STEEL COMPANIES, Ltd, announces that Mr. J. D. Wright has been appointed manager of the Templeborough melting shop of the Steel, Peech and Tozer branch from July 1. He succeeds Mr. H. H. England, who has resigned.

MR. H. R. BROOKER joined the board of Johnson, Matthey and Co., Ltd., on June 15, 1961, as a joint managing director. He has hitherto been general sales manager and will continue to be principally responsible for all the sales divisions of the company.

MR. M. T. MARWOOD has been appointed sales manager, marine department of Associated Electrical Industries telecommunications division. He succeeds Mr. W. E. Warren, who is remaining with the department in a consultative capacity until the end of November.

PETBOW, Ltd., Sandwich, Kent, announces that as from July 1, 1961, it has taken over Vernons Industries, Ltd.'s Liverpool factory and all the manufacturing rights on its range of aircraft ground starting and servicing equipment, high frequency alternators, converters, &c.

MIDLAND INDUSTRIES, Ltd., states that Mr. D. L. C. Rees has been appointed financial director and Mr. F. H. Hipkin commercial director of Boston Marine and General Engineering Company, Ltd. Mr. B. Robinson has been appointed to the board of Bettles and Sons, Ltd.

THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS has elected the Hon. H. G. Nelson as president of the Society for 1961-62, with Sir Roy Dobson as vice-president. Sir George Dowty, who was president in 1960-61, becomes deputy president. Sir Frederick Handley Page, C.B.E., has been re-elected treasurer.

MIDLAND SILICONES, Ltd., announces the following appointments to its board of directors : Mr. A. K. Simcox, general sales manager, becomes sales director; Mr. J. S. Hughes, manager of the process and product development department, becomes development director ; Mr. H. N. Fenn, a director of Dow Corning Silicones, Ltd., U.S.A., with whom Midland Silicones are closely connected.

MR. C. ERIC STEWART, M.I.E.E., has returned to this country after twelve years as general manager for Johnson and Phillips, Ltd., in India. He has joined the head office of J. and P. at Charlton where he will be engaged on duties related to its overseas business generally. Mr. Reginald E. Negus, A.M.I.E.E., has succeeded Mr. Stewart as general manager in India.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., states that Mr. A. T. Stretton, A.M.I.Mech.E., A.M.I.E.E., has been appointed assistant manager of the small industrial machines engineering department, Birmingham, A.E.I. motor and control gear division. Mr. T. W. Haycroft, A.M.I.Mar.E., has been appointed assistant education manager, craft apprenticeships at Associated Electrical Industries (Manchester), Ltd.

MR. J. E. C. BAILEY has been appointed to the board of Derbyshire Stone, Ltd. He will continue his executive duties in the Baird and Tatlock Group, as chairman and managing director of each of the operating companies in that group, comprising Baird and Tatlock (London), Ltd., Hopkin and Williams, Ltd., and W. B. Nicolson (Scientific Instruments) Ltd., all members of the Derbyshire Stone Group of Companies.

MR. J. L. THOMPSON, general manager and director of Square D, Ltd., has been appointed managing director. Mr. D. Gemmell, A.M.I.E.E., executive director, has been appointed general manager of the company's Swindon establishment. Mr. Gemmell heads the Engineering and Manufacturing Divisions of the company and was appointed executive director in July, 1960. Mr. R. G. Camp, sales manager, has been appointed executive director.

THE INSTITUTION OF STRUCTURAL ENGINEERS announces that the following honorary officers and members of council have been elected for the session 1961–62 and will take office in October : Mr. F. R. Bullen, M.I.C.E., president, and Mr. E. N. Underwood, M.I.C.E., Mr. F. M. Bowen, M.I.C.E., Assoc.I.Mech.E., Mr. H. C. Husband, M.I.C.E., M.I.Mech.E., Mr. D. A. G. Reid, M.I.C.E., Dr. D. D. Matthews, M.I.C.E., Mr. Brian Scruby, vice-presidents.

QUALCAST, Ltd., announces that Mr. S. Webster, departmental director in charge of lawn-mower production, has taken over the entire control of the lawn-mower section of the Group, comprising : Qualcast, Ltd., Lawn-mower Division, Sunnyhill, Derby, Suffolk Iron Foundry (1920), Ltd., Stowmarket, Suffolk, Follows and Bate, Ltd., Gorton, Manchester, 18. He replaces Mr. H. Clarke as chairman of Follows and Bate, Ltd., and chairman of Suffolk Iron Foundry (1920), Ltd., upon Mr. Clarke's appointment as assistant managing director of the parent company, Qualcast, Ltd. Mr. Clarke has resigned from the boards of the lawn-mower subsidiary companies.

Business Announcements

BEARD AND FITCH, Ltd., has moved to a new factory in Edinburgh Way, Harlow, Essex (telephone, Harlow 25358).

MR. P. P. C. DRABBLE, production director of Geo. Salter and Co., Ltd., has left the company in order to devote himself entirely to a literary career.

RHODES, BRYDON AND YOUATT, Ltd., announces that its London offices at 76, Victoria Street, have been moved to 45–51, Leman Street, London, E.1 (telephone, Royal 1212).

Q.V.F., Ltd., has opened an office at 55, New Bond Street, London, W.1 (telephone, Mayfiair 0346). The office will be used primarily as a contact and communications centre.

WHITEHOUSE INDUSTRIES, Ltd., announces that its head sales office has been transferred to new premises at the company's works at Monkhill, Pontefract, Yorkshire (telephone, Pontefract 2011/2/3).

THE BRITISH WAGON COMPANY, Ltd., has opened a new branch office at Rotherham House, 229, Manningham Lane, Bradford, 8, Yorks (telephone, Bradford 46745/6). The branch manager is Mr. P. P. Jones.

ALFRED HERBERT, Ltd., Coventry, officially opened a new branch office at 311, Dewsbury Road, Leeds, 11, on July 3. In addition to the normal offices the new branch building incorporates a warehouse and showrooms which will accommodate over 100 machine tools.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., has formed a new division to manage the company's home district offices. Mr. V. S. Risoe, M.I.E.E., has been appointed general manager of the new division and will take up full time duty on August 1.

F. PERKINS, Ltd., Peterborough, has signed an agreement with NSU Motorenwerke Aktiengesellschaft and Wankel G.m.b.h., West Germany, to manufacture NSU Wankel engines under licence in the United Kingdom. The agreement enables Perkins to manufacture petrol marine motors and diesel motors.

MARTIN, BLACK AND CO. (WIRE ROPES), Ltd., Coatbridge, near Glasgow, has now opened a wire rope depot at 4, Stockbridge, Manor Chare, Newcastle, 1. The north-eastern area office, under the management of Mr. A. R. Jenkin, has also moved to the new address, but retained the previous telephone number (Newcastle 2–1282).

STEDALL MACHINE TOOL COMPANY, 192–204, Pentonville Road, London, W.1, has been appointed by Impregnated Diamond Products, Ltd., distributors of the " Sparcatron " range of spark erosion machines used in the manufacture of press tools, forge dies, &c., and " Sparcard " tungsten carbide impregnating machines for cutters, lathe tools, &c.

WILLIAM H. CAPPER and Co., Ltd., under a reorganisation programme, has disposed of one of its small works in Warrington and concentrated production at the Woolston, Warrington, works, which have been rebuilt and extended at a cost of £80,000. The new premises have been designed to take advantage of modern production methods and equipment for fabrication of pipes and specials, and heat exchangers, coils and condensers, as well as the chemical pumps and special purpose machines of its subsidiaries. The new premises include two main fabricating shops of 400ft by 120ft and the equipment includes facilities for hydraulic testing up to 10,000 lb per square inch. Other equipment includes gas, electric, argon arc and submerged arc welding plant and facilities for coiling pipes up to 6in internal bore.

Contracts

THE MITCHELL CONSTRUCTION COMPANY Ltd., has been awarded by the Midlands Project Group of the C.E.G.B. a contract for the construction of the superstructures of the principal buildings of Drakelow " C " Power Station at Burton-on-Trent which is valued in the region of £1,200,000. The consulting engineers are L. G. Mouchel and Partners.

JOHN LAING AND SON (CANADA), Ltd., has been awarded contracts, worth about 1,000,000 dollars, for the construction of two avalanche sheds over the Trans-Canada Highway near Lanark in British Columbia, by the Provincial Department of Highways. The sheds are designed to maintain an all-weather route and work must be completed by early November.

A. WADDINGTON AND SON, Ltd., has been awarded a contract amounting to £659,515 for the main civil engineering works and the building works involved in stage I of the London County Council's flood relief scheme in Wandsworth. The contract includes the construction of the Falcon Brook pumping station and part of a low-level relief sewer. The complete scheme will cost £1,350,000.

RICHARDSONS, WESTGARTH AND CO., Ltd., Wallsend, has received an order from the Government of Curacao for two vacuum flash evaporators, each capable of producing 1,400,000 gallons of drinking water a day. These units will have a larger individual output than any evaporator so far built and the order, which is worth approximately £500,000, is scheduled to be delivered in less than twelve months. The consultants for this contract are Stichting Nederlands Adviesbureau Voor Ingenieurewerken in Het Buitenland, The Hague, in association with Tebodin, Advies-an-Constructionbureau N.V., The Hague.

CROWLEY, RUSSELL AND CO., Ltd., has been awarded a contract valued at £1,840,000 for the construction of a by-pass of almost 4 miles between North of Denny and Haggs, Stirlingshire, on the Glasgow–Stirling trunk road. The scheme involves the provision of dual carriageways throughout the by-pass, with accompanying fly-overs, under-passes, slip roads, culverts, the construction of fourteen road bridges, and other ancillary works. The County Surveyor of Stirling is responsible to the Secretary of State for Scotland for the scheme, and the consulting engineers for the bridges are Messrs. F. A. Macdonald and Partners. The works are expected to take twenty-three months to complete.

Indian Engineering News

By OUR CORRESPONDENT IN INDIA

Coal in India's Third Plan

On the basis of the target for steel, thermal power and railways which are major users of coal, India's demand for this commodity by the end of the period 1965–66 is expected to be of the order of 97,000,000 tons. This will require production to be stepped up by 37,000,000 tons over the goal of 60,000,000 tons set for 1960–61. To ensure adequate supplies of coking coal for the steel industry, and of high-grade non-coking coal for railways and certain other industries, the extra tonnage to be extracted includes 11,000,000 tons of coking coal and 10,000,000 tons of semi-coking and blendable coals. These will have to come mainly from the Jharia and Raniganj coalfields which are at present wholly in the private sector. It is tentatively assumed that 16,000,000 additional tons of coal could be raised by the private sector. The balance of 21,000,000 tons needed in regard to other grades of coal will have to come largely from the outlying coalfields like Karanpura in Bihar and those of Madhya Pradesh, Orissa and Andhra Pradesh. For the present a provision of Rs.138 crores has been made for the coal programme in the public sector. In addition, some sum for raising coal is included in the allocation of Rs.200 crores for the Bokaro steel plant and its ancillary facilities.

The railways are still the largest single users of coal in India. The Coal Council's utilisation committee has pointed out that unless some quick and firm decisions are made regarding the relative proportions of steam, diesel and electric traction to be used on the railways during 1961–66 no precise assessments of this coal requirement can be made. It will, moreover, be necessary to ascertain their demand regionwise so as to determine the needs of beneficiation of coals for them and allocating coal-washing plants fieldwise. Without adequate information on the amount of traffic to be based on steam the assumptions of the coal needs of the railways would prove wide of the mark.

With the diversion of coking coals hitherto used by the railways to the iron and steel industry, difficulties have cropped up in the provision of selected grade non-coking coals for use in steam locomotives. The Coal Controller is effecting this changeover from coking to non-coking coals not only in the case of railways, but among other non-essential consumers of coking coal as well. The suggestion is frequently made that increased use of diesel traction on the railways will bring down their demand for coal. Unfortunately at the present time there is an imbalance between the demand for and availability of different types of petroleum products. The shortage of middle distillates—diesel oil and kerosene—is already acute. The Coal Council's utilisation committee has therefore recommended a closer examination of the possibilities of producing diesel oil on a large scale synthetically from coal and its by-products. Another aspect of the coal economy calling for solution is the maintenance of a cushion of metallurgical coal supplies, since all such coal extracted may not conform strictly to the specification of steel plants. It has been computed that for approximately 10,000,000 tons of ingot steel production and 2,000,000 tons of pig iron output envisaged in 1965–66 coking coal requirements would be of the order of 19,000,000 tons and semi-coking or blendable coals 6,000,000 tons, making a total of 25,000,000 tons. This figure would stand corrected to the extent that a part of the steel capacity is realised through electric furnaces and by using lignite coke. Although the additional quantity of metallurgical coke needed would be around 6,000,000 to 7,000,000 tons it is felt that some buffer stock is necessary, and it is proposed to plan for an extra 9,000,000 tons of coking coal. This quantity of metallurgical coal must in the main come from the Jharia coalfields, where private colliery companies are being sounded on the additional capital outlay which would be necessary to attain an output of this magnitude. Latest official estimates of coal reserves in the Jharia coalfields place the quantity at 589 million tons. The supply position of coking coal is expected to get easier when the Durgapur coal washery starts production next year. India now has two washeries at Karguli and Durgapur, and the construction of the other two of Hindustan Steel at Pathardih and Bhojudih is progressing satisfactorily.

Another related problem pertains to the depletion of sand supplies to the Jharia coalfield. Any proposal for the construction of further dams on the Damodar River would have the effect of denuding replenishment of sand in the river alongside this strategic coalfield. It may render the present sand stowing scheme for the collieries either unworkable or uneconomic. The Ministry of Irrigation and Power has therefore been asked to bear this in mind when deciding the issue of building further dams in this area. In its turn the Ministry has requested its committee on augmentation of water to examine the repercussions of dam construction on the availability of stowing sand for the collieries.

Development in Damodar Valley

The United States has granted a loan of 73,000,000 dollars (Rs.34.8 crores) to India partly in rupees and partly in dollars to meet the entire cost of the 250,000kW thermal electric power plant near Chandrapura in the Damodar Valley. It will be the largest Indo-American economic project to be financed exclusively with U.S. funds. This undertaking will help to alleviate power shortage in India's highly industrialised Damodar Valley in the States of Bihar and West Bengal. Also, the U.S. has reached agreement in principle with the Government of India for a Rs.12 crores project calculated to add 120,000kW capacity to the Durgapur thermal power station in the Damodar Valley, West Bengal. Of the total amount Rs.9.5 crores will come from a loan from the U.S. Development Loan Fund. Local currency costs in the amount of Rs.3.4 crores will be derived from Public Law 480 sale proceeds. This is the fifth Development Loan Fund loan announced in recent months for power projects in India. The Durgapur plant is nearing completion with an installed capacity of 150,000kW. The Development Loan Fund loan will make possible the addition of two 60,000kW steam turbo-generators, two coal-fired boilers with 700,000 lb per hour capacities, auxiliary equipment including coal handling facilities and electric control and switchgear equipment. The power from the Durgapur plant will be used in its immediate vicinity by expanding newly contemplated industries in such fields as aluminium, steel, automobiles, jute, paper and glass.

PETROLEUM IN JAPAN'S ENERGY PICTURE

No other country has attained a rate of growth since the second world war to match that of Japan. Between 1951 and 1959 its manufacturing output virtually tripled and its Gross National Product (GNP) jumped 119 per cent. Its prices rose by a mere 2 per cent. over this period, a singular achievement in the context of such phenomenal progress. At an annual average of 10·3 per cent Japan's GNP showed a higher rate of increase than in any other country including West Germany and Russia. During the financial year ending March, 1960, its GNP rose 16 per cent and manufacturing output 29 per cent. But for the period ending last March the increase is expected to be less. Even so the upward trend in economic growth is unmistakable and it is reckoned to continue for years to come.

This economic boom has stimulated a demand for all forms of energy, and meant an unparalleled rise in oil consumption. According to the latest forecast by the Japanese Economic Deliberative Council a total capital investment of 6300 billion Yen (the equivalent of 17·5 billion dollars) will be required to ensure that the country's rapidly growing energy requirements are met during the period up to 1970. Of this sum 960 billion Yen are for oil and natural gas (130 billion for crude petroleum and natural gas production, and 830 billion for the other sectors of the industry). The indicated investment per ton of new annual capacity is some 15,000 Yen (say £15). This is inclusive of replacement of existing facilities.

The earlier forecasts of the Economic Planning Agency, EPA, for 1970 (interims of coal equivalent) were coal 71·4 million tons, oil 107·9 million tons, natural gas 1·6 million tons and hydro-electric power 52·5 million tons, making a total of 238·5 million tons (*vide* Table I). The new figures by the Japanese Economic Deliberative Council in respect of oil, at approximately 89,000,000 metric tons of actual oil, are higher by some 20,000,000 tons of actual oil than the EPA forecasts. At this higher rate petroleum would account for an estimated 50 per cent of the total of the country's energy supply by 1970. If the forecast is realised Japan's total imports in 1970 will be around 1,700,000 barrels a day (b/d) of actual oil, or four-fold the 1959 figure of 441,000 b/d. This forecast is based on the reasonable assumption of an average annual rise in GNP by 7·2 per cent to 26,000 billion Yen, and an increase in population from 93,000,000 in 1959 to 102 million in 1970.

Japan's estimated inland consumption of petroleum products during the four years, 1956 to 1959, is given in Table II. Demand is expected to go up by an annual average of 13 per

TABLE I.—*Japan's Sources of Energy Supply*

(Million metric tons of coal equivalent)

	Average 1956–58	Forecasts 1970	Forecasts 1980	% Increase 1980/ 1956–58
Coal and lignite production	45·8	48·9	48·9	7
Imports of coal	5·3	22·5	31·9	502
Crude oil production	0·5	1·4	1·4	180
Imports of crude oil	21·0	92·2	173·3	725
Imports of oil products	3·3	14·3	26·9	715
Total oil as actual tons of oil (*a*)	16·6	72·0	134·0	708
Natural gas	0·4	1·6	2·5	525
Water power	34·0	52·5	63·0	85
Wood charcoal	6·1	5·1	4·6	— 25
Total energy (*b*)	116·4	238·5	352·6	203
Oil as percentage of total energy	21·3	45·3	57·2	—

Source : Economic Planning Agency of Japan.
(*a*) Conversion from tons of coal equivalent by using factor 1 ton of oil = 1·5 tons of coal.
(*b*) Excluding refinery fuel and loss.

TABLE II.—*Japan's Estimated Inland Consumption of Petroleum Products*

(Million metric tons)

	1956	1957	1958	1959
Gasoline	2·5	2·8	3·0	3·4
Kerosene	0·8	0·9	1·0	1·3
Gas/diesel oils	2·1	2·4	2·8	3·1
Fuel oils	5·4	7·2	7·0	8·5
Other products	1·0	1·0	1·1	1·3
All products	11·8	14·3	14·9	17·6
Percentage increase on preceding year	+19	+22	+ 4	+18

cent with accent on black oils, especially fuel oil. Sales of fuel oil have been helped by low import prices and freights, and the inability of the domestic coal industry to lower its costs. Kerosene continues to be used increasingly for cooking and heating in place of charcoal, the traditional fuel. A substantial rise in demand for liquid gas is envisaged, and the volume of feedstock needed year by year by the waxing petrochemical industry will mount up. Consumption of gasoline and gas diesel oil has been growing steadily with the growth in the vehicle population. By granting loans for modernisation the Japanese Government is encouraging the coal industry and power supply undertakings to slow down the pace of conversion to petroleum. In addition it imposed in April, 1960, an import duty of up to 7 per cent on crude oil and 10 per cent on heavy fuel oil, against the previous 2 and 6½ per cent respectively. Even so the pronounced trend towards wider adoption of oil fuels continues, and the highly competitive Japanese petroleum industry is striving, not without success, to satisfy the country's liquid fuel needs. Foreign investment has contributed handsomely to the building up of oil refining and marketing in recent years, through partnership companies most of them equally owned by foreign and Japanese oil companies. Japanese industrialists have a tradition of acquiring know-how through technical assistance agreements on a royalty basis with foreign firms, and they have continued to do this on a big scale in the post-war years.

Japan's domestic crude oil production is negligible in relation to consumption. It rose from 367,000 metric tons in 1958 to an estimated 500,000 tons last year. Inland oil exploration and production is encouraged through the state-owned Oil Resources Development Company. Drilling the third successful off-shore well early in the second half of 1960 near Tsuchizaki, this company found oil at a depth of approximately 2000ft. When in regular production these three wells are expected to yield some 650 b/d. The fourth well is being drilled to a depth of 6000ft. The country's modest gas reserves were increased when Teikoku Oil tested a gas strike at 35,000,000 cubic feet daily. The first turbo drilling ever used in Japan went into operation last January. Three sets of 6¾in Model T12 M3 drills have been purchased from Russia by Teikoku Oil for development drilling in Katamachi field on oil and gas wells in the 3900ft–6500ft range. Each drill costs nearly 7000 dollars including attachments. The present five-year plan for domestic oil development ended on March 31, and a new plan is being formulated for which the necessary government financial support will be forthcoming.

Japan's oil imports already take 10 per cent of the country's foreign exchange. The new basis for foreign exchange allocations for crude and fuel oil imports was announced by the Ministry of International Trade and Industry in mid-1960. It is still based 50 per cent on the value of exchange allocated in the previous three years, but the weighting of quantity actually imported has been reduced to 25 per cent. The remaining 25 per cent will in future be based on the value of the products obtained from imported crude oil. Foreign exchange allocations for oil imports in the period April–September, 1960, was 192 million dollars (157 million dollars for crude oil), 15 per cent more than on the previous six months and an increase of 37 per cent on the corresponding period the year before. This higher allocation, together with lower prices, is expected to make possible crude oil imports in the April–September, 1960, period 50 per cent larger than a year previously. For the October–March (1960–61) period the foreign exchange allocation has been stepped up to 240 million dollars to cope with higher import needs.

Japan is taking several steps to reduce the strain on her foreign exchange reserves. Two Japanese groups, the Arabian Oil Company and the semi-government Japan Petroleum Exploration Company, are developing foreign crude oil supplies. The former has now completed nine wells, all with yields of some 6000 b/d., and is drilling the tenth well at the Khafji field off the Neutral Zone in the Persian Gulf. Production is to start before the middle of 1961. Arabian Oil's sales of crude petroleum to Japanese refineries will certainly be looked upon with favour by the authorities since on balance its operations will earn, or economise, foreign exchange for Japan. The Japan Petroleum Exploration Company has concluded a deal for at least 12,000 b/d. of oil for ten years from fields in North Sumatra controlled by the Indonesian Government. Finally, under the Soviet-Japanese trade agreement of 1960 Japan would import 6,000,000 tons to 8,000,000 tons of Soviet crude oil over the next six years, bartering in return tankers and large diameter pipe.

The operable capacity of refineries in Japan at the beginning of this year of 726,720 barrels per stream day or, say, 37,000,000 metric tons a year, is well above the current rate of domestic demand of approximately 25,000,000 tons per annum. Since consumption is reckoned to go up very rapidly there has been a rush to get pre-emptive authorisation for new processing plants. Some 18,000,000 tons new capacity is to be built by the end of 1962, and a further 5,000,000 tons or so by 1964. Beyond these firm projects, there are plans pending for nine plants scheduled for completion between 1965 and 1970. The largest new refinery now envisaged is a 10,000,000 ton plant to be erected at Nishinomiya by Nippon Oil Company in 1970. Most of the larger refineries will have petrochemical facilities attached to them. Several Japanese industrial companies have oil refining interests, notably the leading vertical combines Mitsui, Mitsubishi and Sumitomo, as well as Esso, Mobil, Caltex, Shell and Tidewater.

Most marketing is done by affiliates of Western Companies : Stanvac with 55 per cent interest in Toa Nenryo Kogyo ; Caltex with 50 per cent interest in Nippon Oil ; Shell with 50 per cent interest in Showa Oil, and Tidewater with 49 per cent interest in Mitsubishi. But three big independents—Idemitsu, Maruzen and Daikyo—handle nearly 30 per cent of total sales and are growing both in volume and share of the markets.

In less than a decade Japan has made a successful bid to join the ranks of the world's leading producers of petrochemicals. Her activity in this fast growing field falls into two divisions—that based on natural gas and that on petroleum fractions and refinery gases. The first division had its start in 1952, and was well advanced before the second came into existence five years later. The industry utilising natural gas produces methanol, ammonia, ammonium sulphate, urea and several compound fertilizers. In April, 1957, the Shimotsu refinery of Maruzen Oil Company started producing solvents like secondary butanol and methyl ethyl ketone from refinery gases. This was the first step in a five-year petrochemical development programme which resulted in an investment of 228 million dollars by thirteen companies in fourteen plants. Japan's sales of petrochemicals have risen sharply from 4·2 million dollars in 1957 to an estimated 220 million dollars in 1960. Early last year some two dozen companies, nearly half of them newcomers, applied for permission to build new petrochemical facilities, or to enlarge existing units. Plans already under way indicate that plant investment in a second five-year programme may well exceed 300 million dollars. The country's annual output of polyethylene plastic is to go up from 70,000 to 140,000 metric tons. Plans for setting up its first polypropylene plants envisage an initial capacity of 55,000 tons a year. The overall capacities of styrene monomer and polystyrene facilities are to be stepped up from 15,000 tons and 25,000 tons to 40,000 tons and 60,000 tons respectively. Other products whose manufacture, or expansion, is planned include alkyl benzene detergents, tetraethyl lead (TEL), acetylene, ethyl and butyl alcohols, synthetic special-purpose and general-purpose rubbers, ethylene derivatives, aromatics, acids and solvents of various kinds.

Producers of petrochemicals in Japan enjoy tax exemptions in various forms as well as special facilities for quick depreciation and the acquisition of funds and long-term loans from the Development Bank. Most of the major industrial groups in this sector are linked in one way or another with American and European interests, and the Government continues to allow foreign concerns to participate financially and to accord active technical co-operation in the building up of the country's petrochemical industry. Its growth means increased savings in foreign exchange outlay on imports of highly priced chemical products. Already in 1960 such savings were computed equivalent to some 100 million dollars. Exports of petrochemicals promise to earn for the country foreign exchange.

Japan has also forged ahead as a builder of giant tankers. This is due to modernisation of shipyards, low costs, quick deliveries and excellent workmanship, backed by State subsidies to shipbuilding steel. The tonnage of tankers launched rose sharply with one setback to a peak of approximately 1,400,000 gross tons in 1957. Apart from the former naval dockyard at Kure, now owned by the U.S. Ludwig interests, there are in all fourteen shipyards capable of constructing super-tankers. The most outstanding performance of the Japanese yards was the delivery of " Universe Apollo " of 104,500 tons only seven months after laying the keel. The biggest tanker at present afloat, " Universe Daphne " of 107,400 tons d.w, was built at the Kure shipyard. Last year Idemitsu ordered from Japanese yards two tankers, each of 130,000 tons d.w., the employment of which is reckoned to reduce the cost of transporting oil from the Persian Gulf to Japan by some 30 per cent as compared with vessels of 45,000 tons. The first is scheduled for completion in October, 1962, and the second a year later. Each of these mammoth tankers will cost around £5,300,000.

Because of recent recessions in shipping and shipbuilding, buyers have become much more price conscious. For this reason Japan's prices were drastically reduced in 1959. The " Universe Daphne " was priced at approximately £6,000,000 (say £55 a ton) and the " Naess Sovereign " of 87,500 tons d.w. at £49 a ton. Early in 1960 prices as low as £47 a ton were quoted. The level of prices ruling in Western Europe range from £55 to £65 a ton. Moreover, it is customary for foreign purchasers to pay only 30 per cent of prices up to the time of delivery and to spread the balance over a period of six to seven years. Interest on shipbuilding credits varies from 5 to 5·5 per cent. For domestic buyers the Government has a scheme whereby the owners may borrow 40 per cent of the cost in the case of tankers. Last December Russia bought six tankers aggregating 219,840 tons from Japan. This deal is part and parcel of the Government's efforts to expand exports and, in particular, to support its profitable and strategic shipbuilding industry. The Russian ship purchasing mission has expressed its desire to order still more super-tankers from Japan if this can be covered by deliveries of Soviet crude oil on long-term arrangements.

At present the only Japanese-built liquid gas carrier in service is a 1000 ton coastal vessel of pressurised type employed on short runs between local petrochemical and synthetic rubber plants. But Japan has plans for building ocean-going carriers of refrigerated type in anticipation of a rapid rise in large-scale imports of liquefied petroleum gas (LPG) for the home market. A refrigerated LPG tanker of 15,000 tons gas carrying capacity was ordered early in 1960 by the Bridgestone Tyre Company of Tokyo which had entered into a ten year agreement with the British Petroleum Company for an annual import of 140,000 tons of LPG from Kuwait. It is due for delivery by the end of 1961. Also Tokyo Kako Kensetsu, a Japanese chemical construction company, has been awarded a contract worth £1,000,000 by National Iranian Oil Company for the erection of an LPG plant near Abadan and for the export of its production. For this special tankers will be required which will add appreciably to the value of the contract.

In short, oil products will be called upon to play an increasingly important part in Japan's energy picture. She has taken several concrete steps to meet this growing demand. They include encouraging domestic search for and production of oil and gas ; developing foreign production as from the Persian Gulf ; purchasing foreign crude oil under long-term contracts or barter arrangements; fostering a thriving home refining and petrochemical industry and building mammoth tankers and LPG carriers both to conserve and earn foreign exchange. To achieve her ends she has not hesitated to enlist the financial and technical collaboration of industrially advanced Western countries.

CONTINENTAL AFFAIRS

by Our Continental Editor

Continental Airport Developments

No. I

Increasing passenger traffic and the use of larger and heavier aircraft, notably jet airliners, is forcing the pace in many countries as regards improvements to passenger buildings, movement control, and runway installations. In our issue for November 13, 1959, pages 613-617, we dealt with the expansion of the Paris airports of Orly and Le Bourget. On the following pages will be found a brief account of similar work and projects concerning the international airport at Stockholm–Arlanda, and that of the Austrian capital at Schwechat.

Arlanda International Airport

ALREADY in the mid-1940s it had become clear to the Swedish authorities and to the airlines that the country would soon need a larger new international airport, as a consequence of the big aircraft that were being developed and the general expansion of civil aviation that was foreseen after the end of the war.

The question of a suitable site was widely discussed in the years 1946-1957 and during this time many different solutions to the problem were put forward. Eventually the site at Arlanda was chosen and on December 18, 1957, the Swedish Parliament adopted the Arlanda Plan. Two years later, on December 14, 1959, the Minister of Communications declared the runway officially open to air traffic, thereby marking the completion, ahead of schedule, of the first phase of construction. The Scandinavian Airlines System (SAS) transferred the bulk of its programme of flight training to Arlanda, and since January 5, 1960, the airport has been open to regular air traffic.

According to present plans, airport construction will be completed in 1963, although the new permanent air terminal will not come into service until 1966. In the course of 1960-1963 traffic is being transferred from Bromma, Stockholm's other civil airport, and practically all four-engined aircraft will be directed to the new airport. After this transfer has been completed, all international flights will land at and take off from Arlanda, while domestic services will be concentrated at Bromma.

Runway and Taxiway Systems.—The runways comprise runway 01-19 which is the main instrument runway, and runway 08-26 which is to be ready by 1962, together with taxiways. The length of the main runway is 3300m and it has a total width of 70m of which 45m is in concrete, while the 12·5m wide shoulders are asphalted. The secondary runway will have the same cross-section but its length will be limited to 2500m. These runways are set in strips 300m wide and 3720m and 2620m long, respectively. On the main runway the gradient is nowhere in excess of 1 in 200, while the figure for the approaches is 1 in 76 and 1 in 50 on the main runway, and 1 in 150 on the secondary runway.

Taxiways have a total width of 40m, 25m in concrete, with 7·5m wide asphalt shoulders on each side. The *in situ* concrete pavement is 22cm wide and was produced at the peak construction period in the summer of 1959 at an average rate of 4000 square metres a day, equivalent to 900 cubic metres. The maximum for one day was 5550 square metres. Steel reinforcement mats 7·5m by 12·5m were assembled on the spot and up to 45 tonnes of steel reinforcement was placed in a single day.

On the shoulders, two layers of asphalt were put down, representing a total thickness of 12cm. Calculations for the runways were based on the assumption of a single wheel load of 60 tons equivalent to an all-up weight of about 220 tons on a twin tandem undercarriage. This allows a certain margin for developments, as present-day aircraft such as the DC-8 and Boeing 707 support about 140 tons on a twin tandem. Future aircraft of up to 400 tons on a double twin undercarriage will be able to use Arlanda without strengthening of the runways.

Apron Area.—This includes the terminal building and other structures and the control tower, flight kitchens and cargo building as well as the adjoining roads and car parks.

The apron will join up directly with the system of taxiways and runways. Behind it there will be constructed the permanent terminal building which will become, as it were, the focal point of the airport. This area will not be ready until late in 1963. Until then, the apron in front of the SAS hangar will serve as platform for aircraft arrivals and departures and the garage within the operations area will serve as provisional terminal building.

Operations Area.—The operations area comprises the office building, workshop, garage, fire station, heating plant, and oil companies' installations. As has been mentioned, the garage which measures 45m by 60m has been temporarily converted into a passenger terminal and includes an entrance hall of 560 square metres, a departure hall of 320 square metres, customs and immigration offices, as well as offices of airlines and banks and a post office, cafeteria, tobacconist and newspaper stand. Also housed here temporarily is a meteorological office and a briefing office for the crews.

Included in the workshop which measures 45m by 60m are maintenance sections for vehicles, hydraulic and electrical equipment, diesel engines, and a general engineering shop, painters' and carpenters' shop and welding plant, as well as stores and offices. The vehicle maintenance bay alone occupies 900 square metres.

The 33m by 12m office building is a concrete and brick structure in three storeys, with some interior walls movable to make possible an easy re-arrangement of office space. On the ground floor are staff quarters, changing and wash-rooms and the office of the airport foreman. An enclosed passage connects this building with the workshops. On the first and second floor are administrative offices, including that of the airport manager, and a conference room measuring 30 square metres.

The firefighting and rescue unit is located at the airport fire station, a building of 38m by 19m with an engine hall of 24m by 25m. The firemen are recruited from conscientious objectors to military service and are under the command of professional officers.

There are sleeping facilities for 60 firemen in the form of fifteen rooms with four beds each.

Oil installations include six fuel tanks of 100,000 litres each for jet fuel and three smaller tanks, of 50,000 litres each, for aviation petrol. For the time being, aircraft are refuelled from road tankers which are replenished at the tank farm.

Hangar Area.—The hangar area contains the SAS establishment and adjoining aprons of about 90,000 square metres. Our first illustration shows the hangar building which besides hangar space for aircraft, and facilities for overhaul, storage, and maintenance of equipment such as tracks, tractors, passenger steps, engine starting equipment, &c., also contains offices and class rooms for the technical training section, and a staff canteen.

In both appearance and design, the new SAS hangar is unusual. Inspired by the suspension bridge the hangar departs from the traditional method of construction in that its roof is suspended on a series of steel wires instead of being supported along its outer edge on columns. These 77 mm-diameter wires are attached to the central body of the building, and due to the fact that the two halves of the hangar on either side are symmetrical the resultant load is balanced. Due to changes in temperature the roof is subject to slight movements but the setting up of dangerous stresses is avoided

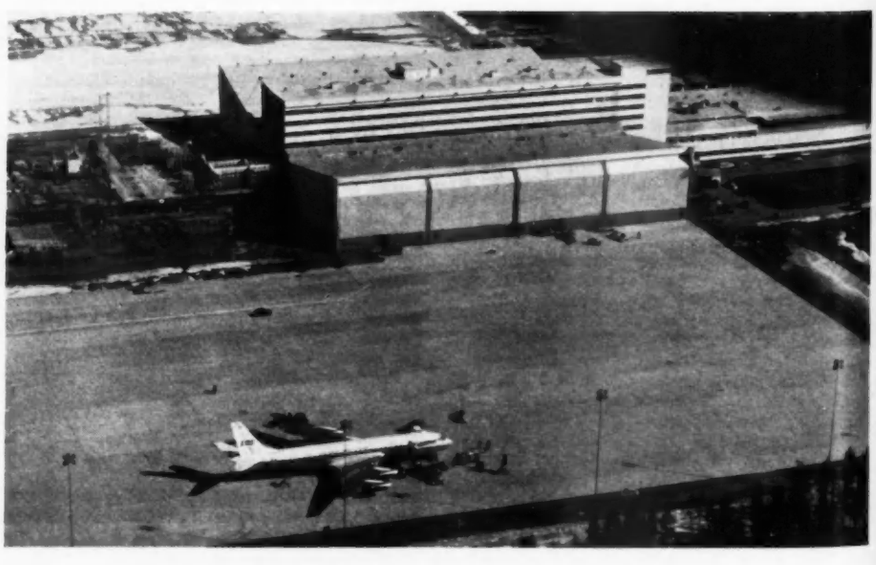


Fig. 1—Scandinavian Airlines System hangar at Arlanda airport

Fig. 2—Interior view of hangar at Arlanda

by making the connection with the control building in the form of a hinge.

In the first phase of construction the hangar can accommodate two DC-8 aircraft on either side. Each of the four bays has a width of 47m thus giving the hangar a total length of 94m. When completed in two years' time the hangar will be twice as large, and will thus be able to accommodate eight airliners of the same size as the DC-8. Inside, the aircraft are placed nose to nose, thus fitting neatly between the pillars which support the central body. This arrangement has practical as well as economic advantages and facilitates overhaul considerably.

Our illustration Fig. 2 shows the interior of the hangar. The view is towards the rear wall where there is a loading dock on first floor level at the same height as the DC-8 cabin doors, with a storage floor above. On the next floor are classrooms, and on the top floor, offices. The upper floors are served by five lifts, two of which are goods lifts. The building is a steel and concrete structure resting on rock foundations. Roof and walls are of light concrete slabs. Windows are surrounded by sound-absorbing material. They cannot be opened for ventilation and in certain sections, air cooling is installed. Heating of the hangar halls is partly by means of tubes embodied in the floor, and partly by hot air ducts in the ceiling and hot air blown in from four rooms situated level with the roof truss.

The frame of the central building is in reinforced concrete. The steel-framed roof on each side has welded plate girders which are hinged to the main structure at second floor level and cantilever outwards by about 43m. The support wires are attached to the central building at roof level to the ends of transverse prestressed concrete beams.

The hangar opening is 16m high. Each bay has two doors of corrugated aluminium on a steel frame, 24m, long and weighing 25 tonnes apiece. Guide rollers at the top of the doors permit the roof to move vertically through a distance of 25cm.

Air Traffic Services.—Flight information and meteorological services are housed in the provisional terminal building and air traffic control in the provisional control tower. Runway and approach lighting, as well as air navigation and radio landing aids, are controlled from the latter. The instrument landing system (ILS) has been installed to serve runway directions 01 and 19 and has a glide path of 2·5 degrees. One surveillance radar (SRE) and one precision approach radar (PAR) are also installed as well as a VDF. The SRE concerned is the first Decca " DASR 1 " ordered for a civil airport. Its aerial, constructed by Société Nouvelle d'Electronique, employs two reflectors arranged back-to-back mounted on a 28m high tower. Coverage is provided over a range of 200km and at heights up to 12,000m. A weather radar is installed on top of the SAS hangar.

The approach lighting for the main runway is a modified Calvert system and comprises 900m long centre lines, cross-bars and warning bars. The runway lighting includes runway lights, threshold lights, wing bars, centre line lights and runway surface lights. This is the first occasion that centre line and runway surface lights have been used in Sweden. The centre line lights are placed at intervals of 30m. Runway surface lights have been installed for 900m along each end of the main runway at intervals of 10m, and are angled on to the runway at 23 deg. By their use, the touch-down zone is illuminated and the " black-hole effect " eliminated. All lights in the approach and runway lighting system with the exception of the runway surface lights are fitted with both high and low intensity lamps. Intensity of the former can be varied between zero and a maximum of 350,000 c.p. in a matter of seconds according to the weather or pilot's request. The total number of individual lights is approximately 3200. Any failures or faults are automatically indicated at the control tower.

Other installations include a 1,000,000 litre water tower, a heating plant with an output of 17,000,000 kcals per hour, and two storage tanks each for 300,000 litres of fuel oil.

The cost of the Arlanda project as originally approved amounted to 153 million kronor, but this has since been increased by 4,000,000 kronor for a cargo building.

Vienna-Schwechat

The flat country to the south east of Vienna on the right bank of the Danube—the region known as the Simmering Heath, and its environs—was the scene of the first flight demonstrations seen in Austria (Lecagneux's trials of a Farman aircraft at Kaisermühlen, Blériot's demonstration of his No. XI Channel aircraft on October 23, 1909, Illner's 45km-flight from Wiener Neustadt and back in May 1910).

Although eclipsed by Aspern (opened in June 1912, and subsequently the chief World War I military and 1922-1945 the main civil airport) the district was used from 1938 onwards by the German Luftwaffe and by the Heinkel Works which installed a 1500m long runway at Schwechat-Heidfeld, the site of the present airport. Completely destroyed by bombing, this airfield, together with Tulln and Vöslau, was restored after the war. In 1947, it began to be used by BEA and later by other civil airlines.

When the end of the occupation made possible the setting up of a modern airport to serve terminal and transit traffic, the choice fell upon Schwechat which is in open country within 17km of the centre of Vienna, with the possibility of installing a fast train service or motorway, and with sufficient scope for expansion to an ultimate capacity of 4,000,000 passengers per annum.

The operating company, Flughafen Wien Betriebsgesellschaft m.b.H. (FWB), was set up on December 11, 1953, and began its work on January 1, 1954, with seventy-four employees. To-day it has over 400, and 210 other persons are employed at Schwechat on the passport and customs services, by contractors, and by the air control. A figure of 2000 will be reached in the not too distant future.

An expansion plan was adopted on the basis of 2,000,000 passengers in 1975—Table I shows traffic developments between 1957 and 1959—and a competition was held in May, 1955, with the object of producing a design for the new airport which while satisfying current needs would be sufficiently flexible so as not to block adaptation to future requirements. After additional design work—no final solution emerged from the competition—it was decided in 1956 to carry out the following as a first stage of the development :

Erection of new terminal building ; construction of roads and parking places ; construction of new apron in front of terminal ; eastward extension of runway by 1000m* ; westward extension of runway by 500m* ; and construction of subsidiary installation and buildings.

This scheme was begun in 1957, and concluded a year ago with the official opening of the new terminal. It involved an investment at the 335-hectare airport of over 228 million Austrian shillings.

* Over and above extension to 2000m in 1954–55

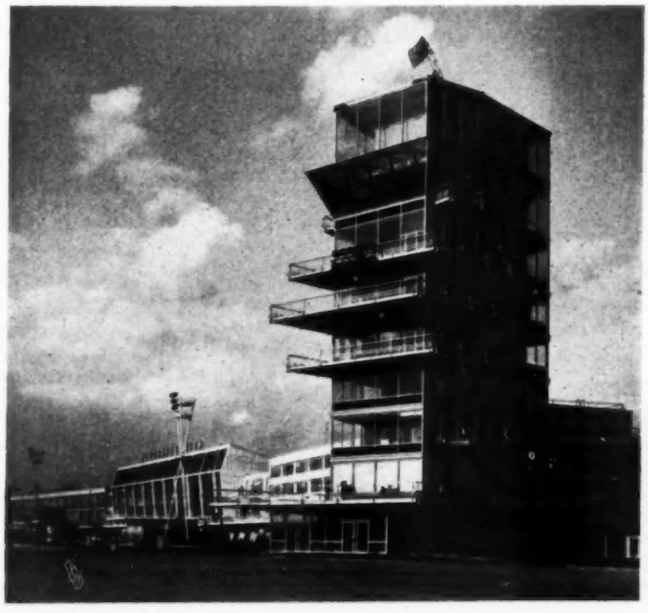


Fig. 3—With the commissioning last year of the new control tower and passenger terminal building (left of centre) at Vienna-Schwechat an important stage has been completed in the expansion of this airport

CONTINENTAL AFFAIRS *(Continued)*

TABLE I—*Development of Vienna—Schwechat Airport*

Year	Passengers (1,000s)			Freight (1,000t's)			Mail (tons)			Aircraft movements (1,000s)		
	Terminal	Transit	Total	Terminal	Transit	Total	Terminal	Transit	Total	Airliners	Other	Total
1954	53·8	10·5	64·3	1·6	0·5	2·1	219	49	268	3·2	0·1	3·3
1955	95·4	17·6	113	2·7	0·75	3·4	302	87	389	5·4	3·4	8·8
1956	161·9	22·3	196·2	4·6	1·1	5·7	443	65	508	8·6	9·2	17·8
1957	210·7	36·4	247·1	5·2	1·5	6·7	703	180	883	11·4	10·2	21·6
1958	239	41	280	1·9	1·3	3·2	775	237	1012	14·1	11·5	25·6
1959	279	44	323	2·1	1·6	3·7	792	255	1047	15·6	10·5	26·1

Facilities at Schwechat correspond to those demanded of an ICAO—Class A airport. Although present traffic can be handled on a single 3000m runway, there is provision in the plan for an extension to 4500m and for a second 2500m-long runway to be constructed parallel with the present one and at a distance of 1·2km to the north-east of it (a so-called " parallel tandem " or " bayonet " layout). Each of these runways would have their own system of taxiways and be connected by taxiways at approximately 45 deg. to the main direction. These connecting taxiways would pass the terminal building or an eastward extension of it. The shorter north runway would thus be used for landing ; aircraft would pass in a single direction to the south runway for take-off.

Extension will also include fuel tank installations, and freight buildings, personnel quarters, district heating plant, and maintenance hangars with workshops and engine testbeds.

Fig. 3 shows a view from the eastern part of the apron towards the control tower and terminal building. The control tower has nine storeys and a basement arranged as follows.

The ground floor forms a covered parking area for cars used by personnel on the airfield. Above is a flight simulator. The balcony as well as the area which it roofs, form points from which visitors can view the activities of the airport. On the second, third and fourth floors are the offices of the area controllers, while on successive floors above the fourth are radio transmitters, radar control, the main control room, and finally, the air conditioning plant surmounted by the aerial of the surveillance radar.

The air terminal is at present approached from the Vienna–Fischament main road with parking spaces in front of the building which consists of a central passenger section, a west wing housing a restaurant, and an east wing which connects it with the control tower and houses the offices of the administration. Aircraft are parked in two rows of docks parallel with the front of the building, and passengers are taken by bus to and from the aircraft. This method of parking the aircraft enables a clear one-way routeing on the apron and taxiways to be maintained.

(To be continued)

Achema Chemical Engineering Exhibition

No. I

DURING the period June 9 to 17, there was held in Frankfurt/Main the thirteenth Achema Chemical Engineering Exhibition and Congress. Jointly with this event took place the thirtieth Meeting of the European Federation of Chemical Engineering, the 1961 Special Meeting and Lectures of the Gesellschaft Deutscher Chemiker, the Annual Meetings of the Dechema Deutsche Gesellschaft für Chemisches Apparatewesen and the Isotopen-Studiengesellschaft, as well as the fifteenth meeting of the European Federation of Corrosion which took the form of a symposium on " The Physical and Chemical Durability of Structural Materials in Chemical Engineering."

About 107 papers and lectures were given before the various sections of the Congress in addition to which there was held a five-day study course for senior students. There was a full supporting programme of social events and works visits.

At the exhibition site of 210,000 square metres exhibits were shown in eighteen halls aggregating 71,000 square metres. Other buildings include three lecture halls (for 150, 400, and 2000 people) and a cinema seating 300.

Exhibits in general were grouped according to subject, and the relative importance of the different sections may be gathered from Table I which sets out the floor space given over to the various sub-groups.

TABLE I—*Distribution according to Branches at the Achema* 1961 *Exhibition*

	square feet	per cent
Research (home and foreign technical colleges and institutions)	3,200	0·35
Scientific and technical literature ...	10,750	1·25
Works techniques	226,000	26·25
Pumps, compressors, fittings...	86,000	10·00
Supplies and auxiliaries	53,800	6·25
Packaging materials and machines ...	37,750	4·35
Accident prevention and safety	8,600	1·00
Chemical technology	15,000	1·75
Nuclear science and technology	22,500	2·60
Laboratory techniques	118,400	13·70
Physical measurements	16,000	1·90
Measurement, control, and automation	80,500	9·40
Construction materials	64,500	7·50
Open air (works techniques, chemical technology, control and automation, construction materials)	118,400	13·70
Total	861,400	100·00

When the Achema Congress was last held in 1958 it was attended by 95,000 scientists and technologists from fifty-seven European and overseas countries.

This year about 1300 exhibiting members of the Congress from fifteen countries presented the latest results of their development work in the field of chemical technology and chemical engineering. A description of some of the exhibits will be found in the following pages.

Wesselinger Gusswerk-Rheinguss

A self-priming pump for acids was shown by Wesselinger Gusswerk-Rheinguss G.m.b.H., Wesseling (Bez. Köln). The pump castings are made of iron with about 15 per cent silicon stated to be resistant to nearly all industrial acids (e.g. sulphuric acid of any concentration and temperature), alkalis, salt solutions and other reagents. The pump which does not require a foot valve is equipped with a spring-loaded self-adjusting carbon ring gland.

Munk and Schmitz K.G.

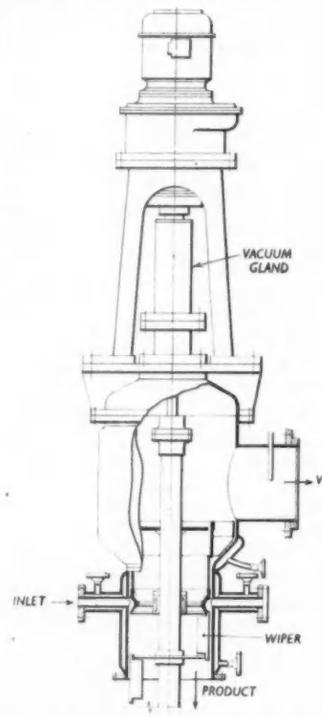
Thin-gauge corrosion resisting linings were exhibited by Munk and Schmitz K.G., Cologne-Poll. The " Rostenit " process uses thin gauge (e.g. 0·5mm to 0·85mm) austenitic steel sheet or special alloy sheets (e.g. Ni Mo Cr), to line vessels, pipes or containers of any size. The base material can be steel or concrete. Steel requires preparatory vacuum sandblasting along the future seams. The lining material which comes in sizes of about 3000mm lengths and 1000mm width is fitted to form butt joints and tacked in position by spot welds. This avoids buckling when finally the joints are sealed by argonarc welding. A combination of the base with the welded material is obviated by placing a protective strip of the same material as the lining under the joint. If necessary, the welds are levelled by grinding.

Aug. Schnakenberg and Co.

Simplicity of design and high efficiency of separation even with very fine dusts is claimed for the " Asco " turbulence washer made by Aug. Schnakenberg and Co., Wuppertal-Barmen. Test dusts of quartz with 43 per cent of particles of under 4 micron, and 10 per cent under 1 micron, are claimed to be separated out with 98 per cent efficiency. The dusty air is drawn downwards at a steep angle against a water surface and enters a horizontal cyclone through a narrow gap between water level and spiral wall of the cyclone. Water particles of optimum size are carried along with the air and help to trap the dust. The washer which is built in sizes from 3000 cubic metres per hour to 84,000 cubic metres per hour contains no moving parts.

Samesreuther and Co.

The firm Samesreuther & Co., G.m.b.H., Butzbach (Hesse), P.O.B.7, showed a film evaporator incorporating a system of wiper blades which ensures that output is in the form of a fully dried powder. We illustrate the equipment which consists of a vertical cylindrical column made up of bolted sections heated by liquid or steam jackets. The wiper blades are arranged on a common shaft at different angles and are freely mobile. The shaft is driven either directly by a geared motor or by way of vee-belts. Pressure of the wiper blades can be adapted to the nature of the product by varying the speed or the thickness of the blades. The shaft passes through a two-stage vacuum-tight gland with pre-vacuum section. At the top of the evaporator just below the inlet, the rotor carries a distributor disc which evenly spreads out the liquid over the periphery after which the required film thickness is produced by the wipers. Above the distributor discs, a rotary foam separator is installed together



Inlet section of evaporator equipped with rotary wiper blades, of which about a dozen are fitted on the same shaft

with a strainer, which serves to prevent small liquid particles from being carried over. The lower end of the wiper is supported in a sealed beaming which can be heated if required.

H. NEUMANN

A heat exchanger designed by Dipl. H. Neumann Techn. Büro, Schopfheim (Baden) Schwarzwaldstr. 52, comprises graphite disc elements with spiral slots machined in opposite faces. These slots, between which only a thin partition is left standing, form the passages for the hot and cold fluids. The slots are closed by graphite end discs.

BURGER EISENWERKE

Glass-fibre reinforced polyester storage tanks of 600–15,000 litres were shown by Burger Eisenwerke A.G., Burg (Hesse). The metal fittings of these tanks are of 18/8 chrome-nickel-steel.

KUNSTSTOFFTECHNIK G.m.b.H.

Radial extraction fans for roof mounting in self-supporting polyvinyl chloride construction were shown by Kunststofftechnik G.m.b.H., Troisdorf (Bez. Köln). The fans, which are mounted with their axis vertical, form part of a complete ducting system made of the same material, and are available in sizes up to 17,300 cubic metres per hour, and for pressure differences up to 56mm H_2O.

ALTENBURGER MASCHINEN K.G.

Continuous classification down to the lowest sizes is claimed to be possible with the micro-classifier "Model B" made by Altenburger Maschinen K.G., Jäckering and Co., Postfach 307, Hamm (Westf.). The solid-laden air enters the cylindrical section of a cyclone tangentially and the heavy components separate out. The mixture passes an adjustable slot which controls the negative pressure produced by additional suction in a second cyclone. In this way a pneumatic gate is formed which separates only the fraction for which the air cushion has been set. The procedure is then repeated in additional cyclones. Units are available for 50 kg and 100 kg sacks, and are equipped with a 20 h.p., 2900 r.p.m. motor for the fan and a 0·5 h.p. geared motor for the gates, as well as gauges indicating the cyclone air pressures. The classifiers are fitted with sight glasses showing the contents.

This equipment supplements the same maker's "Ultra-Rotor" mill which is available in two sizes, with a 38kW motor for an hourly output of 1000 kg, and a 44kW motor for 2000 kg per hour. Up to 200 kg per hour of water can be extracted at the same time from moist materials. The material is fed into the rotor of the machine by means of a funnel and feeder screw. The rotor is fitted with several stages of radial steel plates the distance of which from the casing can be adjusted between 2mm and 15mm. The material is drawn through the rotor by a fan. Grinding is 20 per cent mechanical and 80 per cent by mutual attrition due to turbulence caused by the radial steel plates.

HASLER

Fully automatic dosing machines with continuously adjustable output up to 600 tonnes per hour (accuracy ±1 per cent) were shown by Gebrüder Hasler Waagen- und Maschinenfabrik, Colombier, Switzerland. The machines incorporate hopper-fed belt or chain conveyors or vibrator feeders, &c., arranged either in the form of a two-armed balance for direct weighing or fitted with electro-magnetic load cell. The electrical controls which embody magnetic amplifiers can be arranged for the hourly tonnage of the main component to be pre-selected together with the percentage amounts of additives which then are automatically adjusted to conform with changes in throughput. All quantities are continuously indicated and recorded. Mains voltage fluctuations of ±15 per cent and frequency fluctuations of ±2 per cent do not affect the accuracy.

(To be continued)

Radioactivity in the Human Body

Methods of measuring the total amount of radioactivity in the body of a living person were reviewed at a symposium on Whole Body Counting which was held in Vienna during June 12 to 16. About 130 scientists from twenty-six countries and three international organisations attended the symposium which was organised by the International Atomic Energy Agency.

Accurate measurement of the total radioactivity in a living human is an essential requirement of health and safety measures in the atomic energy industry. So far as the medical users of radioisotopic tracers are concerned, it is often necessary to find out how long an administered radioisotope is retained by the body; such is the case, for example, in the study of iron metabolism. One of the main purposes of the symposium was to discuss how best to use the refined instruments and techniques for such measurements which have become available in recent years. Topics for discussion included: "Properties of Radiation Detectors," "Calibration Techniques," "Typical Whole Body Counting Facilities," "Studies of Natural and Contamination Burdens of Radioactivity," "Data Processing Techniques," and "Clinical Applications of Whole Body Counting." The symposium followed another scientific meeting held by I.A.E.A. in Vienna the week before at which sixty-six experts from twenty countries discussed the effects of ionising radiation on the nervous system. Thirty-five papers were presented and discussed.

Magnetic Journal Bearing

IN certain applications it is of importance to eliminate lubricating oil from bearings because of the danger of contamination, or because the oil itself would be liable to decompose, e.g. under the action of radiation. In other cases the aim is to achieve an almost complete absence of friction or an extreme degree of wear resistance.

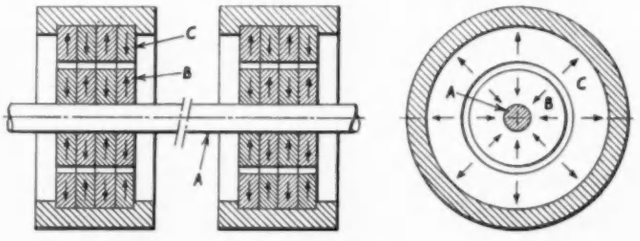
One approach to these problems is the use of magnetic bearings incorporating permanent magnets. A design described by M. Baermann a few years ago* has recently been investigated by the Philips Laboratories of Eindhoven which has verified the underlying theory.†

In the diagram may be seen the principle of supporting a shaft by means of two magnetic journal bearings, one at each end. Each bearing consists of ceramic permanent magnet discs of Ferroxdure I, radially magnetised in alternate directions and placed concentrically with magnetic rings made of the same material and having the same thickness, but magnetised in the opposite direction. Magnetic repulsion will maintain the shaft at the centre of the housing. It has been shown that a number of discs are preferable to a single thick disc, and, in fact, the theory has been developed for an infinite number of discs. In the experiments forty inner and forty outer rings were used in each bearing.

Twice the disc thickness corresponds to the "wavelength" of a sinusoidal or other (e.g. square) magnetic "wave," and it can be shown that the carrying capacity is an optimum when the clearance between inner and outer rings is equal to $\lambda/2\pi$, a result which has been confirmed experimentally. The bearing is stable in a radial direction. In the axial direction, however, the bearing is unstable. That this must be so follows from a theorem due to S. Earnshaw (1842) which states that a permanent magnet in the field of other permanent magnets cannot remain in stable equilibrium. It is of course easy to limit the amount of axial movement by providing suitable mechanical stops. If it is desired to avoid all physical contact with the shaft, a simple electronic servo system may be used.

* German Patent Application B30042 (1954); German Patent Specification, 1,017,871 (1957).

† "Philips Technical Review," Vol. 22, 1960–61, No. 7, pages 232–38.



Principle of magnetic journal bearing. Radially magnetised discs *B* are mounted on a shaft *A* causing it to float inside the housing *C* which consists of rings magnetised in an opposite direction to *B*. A servo (not shown) maintains axial equilibrium

High Level Working Stage

Our accompanying illustration shows the Model "HA 250-12" high level working stage built by Krupp-Ardelt G.m.b.H., Wilhelmshaven. The stage is mobile and because of its great adaptability represents a universally applicable aid for work in places which are difficult of access. Heights up to 13·5m and horizontal spans up to 10·5m can be bridged, and even work on street and railway trolley wires can be carried out without interruption of the traffic. Other applications for which the equipment is suitable include such varied tasks as aircraft maintenance, work on steel structures, difficult roofing work, fire fighting and rescue operations, and the radio-reporting of outdoor events.

High level hydraulic working stage

The insulated platform has adequate room for two persons and their equipment and tools. All movements are controlled from the platform or alternatively from the ground; a telephone connection allows the two sections of the crew to communicate with one another.

Movement of the support is by means of hydraulic cylinders which are fully protected by non-return valves against the effects of a pipe fracture or the failure of oil pressure from some other cause. The variable hydraulic pump is driven by the main engine through a power take-off and clutch and consumes about 15 h.p. When a large radius is to be employed the stability is increased by retracting support jacks. Savings in working time of up to 50 per cent are claimed through the use of the device, as compared with ladders and scaffolding.

THE AMERICAN SCENE

By Our American Editor

Machine Tool Developments

The display at the Chicago Machine Tool Show last year of the "Milwaukee-Matic" by Kearney and Trecker was perhaps most representative of a new trend in the United States toward more versatile automation. This machine has been described as "an automatic factory" and is run entirely by tape control. It automatically selects, picks up and positions drilling tools, boring bars, reamers and hones and performs a multitude of operations, each directed and coded in sequence by the same master tape. The Kearney and Trecker "robot" thus goes considerably beyond most so-called automatic machinery, which normally is geared to perform only a single cycle of operations. The "Milwaukee-Matic" is perhaps the most dramatic symbol of the advances being made on many fronts these days by the American machine tool makers, in an effort to recover the ground lost in the past three years. In that period, the industry suffered several grievous blows. On top of a system of depreciation allowances which it long has considered a major obstacle to sales, it was hit by a sharp decline in orders from several of its biggest civilian customers and by cancellations in military spending. Under that combined impact, aggregate sales dropped from over 1000 million dollars in 1956 to about 700 million dollars last year, and red ink appeared on many an income statement in 1959 and 1960.

To-day, however, the picture is beginning to brighten. The more resourceful firms have been cutting costs by modernising their works. Looking toward the development of new and more versatile machines, they have been investing large sums in research. Some have sought to broaden their markets by going overseas, while at least one, beset by mounting competition from dealers in used machinery, has ventured into that field as well. As a result of all these moves, backlogs once more are beginning to grow, and several firms have grown bold enough to raise prices slightly. Admittedly, business during the first four months of 1961 remained depressed. Yet, with an uptrend in the economy beginning to make itself felt, the industry as a whole now may be on the verge of its long-awaited recovery. Over the years, the industry has reflected in its most exaggerated form the cyclical rise and fall of the American economy. The reasons for the recent three-year slump, which has cut operations to 60 per cent of capacity, are various. The shift in defence spending from manned aircraft to missiles is one cause. The slowdown in Detroit, the general squeeze on industrial profits, and the flight of venture capital overseas are other reasons. The basic causes for the industry's chronic instability, however, go deeper than short-term economic swings. For one thing, while it constitutes the foundation of the American mass-production system, the machine tool industry is a small, localised business. Many firms specialise in only a few custom-made items; in the aggregate, they turn out hundreds of models with virtually no standardisation of parts. Since the expiration of basic patents which set the original firms up in business, other companies have moved in to compete with them. Moreover, price cutting has been aggravated by Government policy. During World War II, Washington financed a major overhaul of machine tool factories to speed up armaments making; it wound up owning 25 per cent of the nation's supply of such tools. Since the war, the Government has been disposing of these, or renting them out to contractors, at bargain prices. Adding to the gloom is the Government's insistence on a fifteen-to-twenty year write-off for equipment—an attitude that is woefully unrealistic in view of to-day's technological advances. Almost two-thirds of American machine tools are obsolete in terms of modern technology. The industry not only has been suffering domestically, but also over the years has been losing its foreign markets. German, British, Italian and French machine tool makers have been enjoying the lion's share of world business. Indeed, while the foreign machine tool makers have been working at full capacity, with an order backlog of eighteen to twenty-four months, the U.S. producers have been sputtering along at 60 per cent capacity, with a backlog of only four months. Ironically, this very adversity, which has resulted in a shorter delivery schedule than that provided by their European counterparts, has enabled some domestic firms to double their foreign business, to about 30 per cent of their total volume over the last two years.

In the face of adversity on all these fronts, the industry has been struggling to improve its competitive position. To-day, there are at least some indications that the long-awaited turnabout in its fortunes may be at hand. For one thing, Congress is in the process of boosting military spending; a step which should bring new orders. Moreover, the big customers of the industry are reporting an upswing in their own operations. Detroit, in particular, has budgeted a 15 to 30 per cent rise in capital expenditures for this year. General Motors is reported ready to retool for a new six-cylinder engine, and the growing use of aluminium engines is expected to increase machine tool orders. Even more important, Government circles show mounting concern about the increasing obsolescence of the nation's industrial plant. The Kennedy Administration recently proposed a new depreciation policy under which a firm will be able to take an income-tax credit on new plant investment, running up to 15 per cent of its spending in excess of its annual depreciation deduction. Accord- to Secretary Dillon, the new proposal, if passed by Congress, should lead to an increase of about 2000 million dollars in plant expenditures over the amount that otherwise would be spent.

On another front, the machine tool makers have been paring their costs drastically. The process, in fact, has helped to lower the industry's "break-even" point, reportedly to less than 50 per cent of capacity. When the uptrend in orders finally does take shape, several of the companies will be in position to achieve an unprecedented profitability. Bullard, for example, which has reported operating losses in each of the past three years, is said to have lowered its break-even point from 32,000,000 dollars to 18,000,000 dollars of sales. The more resourceful companies have been changing their merchandising techniques as well. To combat the indifference of their customers towards obsolescence, some firms, which previously sold only for cash, have initiated leasing arrangement. Jones and Lamson, for one, has announced plans to rent machine tools, with no down payment until thirty days after delivery, for five years, after which the lessee may turn in the equipment or continue to make payments at one-third the original price.

The most important recent technological change in the machine tool industry has, of course, been the introduction of numerical, tape-controlled machinery. Machine tools consist basically of two parts—the cutting device, which does the actual work, and the jigs, fixtures and templates which hold, position and direct the tool during the job. Ordinarily these fixtures are much larger than the tool itself, and are costly to design, transport, and store until ready to be set up for the next job. The new tapes transmit electrical impulses which automatically position and steer the tool and do away with 75 per cent of the cost of these fixtures. A further advantage is that such a tape, when not in use, can be stored in an envelope; enough of them to direct the operations of a factory for months can be filed in a desk drawer. Finally, tapes are giving industry for the first time a means of scientifically predicting and controlling production costs, since the output rate now depends almost entirely on the engineer who programmes the machine.

The break-through in these "numerical control" machines was brought about by the need of missile and jet engine makers for extremely precise metal-working. Eight years ago, the U.S. Air Force subsidised a group at the Servomechanisms Laboratory of M.I.T. to do the pioneering work. When Government funds ran out, machine tool companies financed further research. Last autumn the commercial fruits of this research were in evidence at the National Machine Tool Builders' exposition in Chicago, when a number of participating firms displayed almost a hundred numerically controlled machines. While the future for numerical-control machines seems exceedingly bright, the makers are aware that it will be a major job to educate U.S. industry to their use. With their electronic controls, the new machines cost up to twice as much as the

older ones and create some maintenance, programming and personnel-training problems. Moreover, the industry still is debating how widespread their adoption will be. Some experts point out that these machines, because of their ability to change automatically from one job to another, are suited primarily to short-run, low-volume operations with frequent changeovers. On mass-production jobs, they claim, it is still cheaper to use conventional machine tools. However, proponents of tape-controlled machines retort that 75 per cent of all metal-working falls into the low-run category.

In any event, the pressure on industry to modernise should accelerate the acceptance of the tape-controlled machine. In this connection, Mr. Mark Cresap, the chairman of the Westinghouse Electric Corporation, recently told a forum of machine tool makers: "While the U.S. has a surplus capacity in almost every product now being made, it has a grave shortage of low-cost, efficient productive capacity. The machine that does the job just a little better, just a little faster, is not for us. American industry wants to take a giant step forward when it moves. The equipment we considered modern in August now has to be seriously questioned as obsolete. Many of our approved appropriations have been re-evaluated. We are determined to replace any piece of equipment, even if it is only one or two years old, if the new machine will give us the required return on the added investment." Already Washington is recommending the installation of tape-controlled machines by contractors doing important work on missiles and the space programme. According to a survey by the "American Machinist," about 85,000,000 dollars' worth of tape-controlled machines will be purchased by next December.

In the meantime, the industry is also going after new business abroad. The industrial boom in Europe has created a shortage of skilled labour, causing West German and other foreign manufacturers to look to Austria, Greece, Spain and Italy for manpower. Europeans, consequently, are casting an interested eye on tape-controlled machines. Several American machine tool makers have been preparing for years to grasp just this sort of opportunity. Giddings and Lewis, for example, has moved into the sterling area by setting up a British branch together with a Scottish affiliate. Moreover it has entered the Common Market by acquiring a three-quarters interest in a German plant. Similarly, Brown and Sharpe has established a works in Plymouth, and Kearney and Trecker has acquired C.V.A. Jigs, Moulds and Tools, Ltd. The Cincinnati Milling Machine Company, for its part, has built three factories in England, one in the Netherlands and one in France.

At home and abroad, then, the American machine tool firms feel that the cycle is beginning to turn in their favour. True, for the industry as a whole, new orders as yet have shown no increase over those of a year ago. However, with the economy generally gaining momentum, this basic part of the engineering industry should begin to pick up before many months go by. In the longer run, the growing desire, in Washington and elsewhere, to modernise the obsolescent U.S. industrial plant, should provide a further lift. The long-depressed machine tool companies, therefore, have reason to hope that the wheel is about to come full circle.

Revision of Charges for Enriched and Depleted Uranium

ON July 1, 1961, the U.S. Atomic Energy Commission reduced its base charges for enriched and depleted uranium and increased its use-charge rate. The changes apply to material leased or sold in the future under domestic and foreign arrangements and also to material now under lease, where appropriate. The net effect will be to lower the cost of nuclear power, the reduction varying from one reactor to another. It will also bring into better balance the charges for enriched uranium as compared with current market prices of natural uranium. These changes will reduce the distortion of technology and economics with regard to the use of enriched versus natural uranium in power reactors.

The base charges are a schedule of values the A.E.C. places on enriched and depleted uranium, varying with the percentage of uranium-235 present. (Enriched uranium contains a higher percentage of the isotope U-235 and depleted uranium contains a lower percentage of U-235 than the 0·71 per cent found in natural uranium.) When the A.E.C. sells enriched uranium to foreign governments, generally for fuelling power reactors, the selling price is the same as the base charge. Domestically, the A.E.C. does not sell enriched uranium but leases it, assessing an annual use charge as a percentage of the base charge. The schedule of base charges is also used by the A.E.C. to assess lessees for the amount of uranium consumed or lost. Similar procedures apply to enriched uranium leased to foreign governments for use in research reactors, materials testing reactors, and reactor experiments.

The use-charge rate will be increased from 4 per cent to 4·75 per cent. The new use-charge rate takes account of increases in the cost of money to the U.S. Government since the rate was first established in 1954. Administrative costs to the A.E.C. of leasing material are also included. For most licensed power reactors in the United States, the use-charge for enriched uranium is waived during the first five years of operation. The reduction in base charges varies from 20 per cent for highly enriched uranium to 34 per cent for uranium containing 1 per cent U-235. The reduction in charges approaches 40 per cent as the U-235 assay nears that of natural uranium and ranges up to 63 per cent for depleted uranium.

The reduction in base charges is made possible by decreased costs of natural uranium. The new charges correspond to a price of 8 dollars per pound of uranium oxide (U_3O_8) in natural-uranium concentrates, which is the price established by the A.E.C. under its domestic purchase programme for the period from April 1, 1962, to December 31, 1966. The component of the base charges representing the work of separating uranium isotopes from natural uranium remains the same. The new base charges for enriched and depleted uranium were published in the Federal Register on May 30, 1961. The table below gives examples of the new base charges and comparisions with previous charges.

Examples of Base Charges for Enriched and Depleted Uranium

U-235 assay in weight Per cent	New charges: Dollars per kilogramme of contained uranium	New charges: Dollars per gramme of contained U-235	Previous charges: Dollars per gramme of contained U-235	Per cent reduction
Enriched uranium	(Official base charges)			
90	12,285·00	13·65	17·07	20
20	2,547·00	12·74	16·12	21
10	1,195·50	11·95	15·29	22
5	535·50	10·71	13·96	23
3	281·20	9·37	12·52	25
2	160·00	8·00	11·00	27
1·5	102·60	6·84	9·70	29
1·0	49·90	4·99	7·58	34
Depleted uranium				
0·7	22·60	3·23	5·45	41
0·6	14·80	2·47	4·48	45
0·5	8·05	1·61	3·33	51
0·4	3·00	0·75	2·04	63

The revision of the schedule of charges for enriched and depleted uranium does not affect present commitments by the A.E.C. as to prices for plutonium and U-233 until 1963. An announcement of November 18, 1956, stated that fuel-value prices of 12 dollars per gramme of plutonium as metal and 15 dollars per gramme of U-233 as nitrate shall be applied in any Commission purchases of these materials produced abroad for the period ending June 30, 1963, through the use of fuel obtained from the Commission under civil agreements for co-operation. There will be no changes in those prices during this period. Materials so acquired will be used only for peaceful purposes. The A.E.C. has no commitment for such acquisitions after June 30, 1963, except under the joint U.S.—Euratom programme. The price to be paid for plutonium to be purchased from Euratom under the joint programme is to be equal to the A.E.C. fuel-value price in effect at the time of purchase.

Prices have been guaranteed by the A.E.C. until June 30, 1963, for plutonium and U-233 produced in the United States in licensed facilities. Material so acquired is not restricted to peaceful uses, and the prices take into account the weapon value. There will be no change in those prices during the period covered by the guarantees. There are no A.E.C. commitments for prices to be paid for plutonium or U-233 after June 30, 1963. As nuclear power becomes more nearly economically competitive with other sources of power, it will be desirable to move toward prices of plutonium and U-233 which are determined by normal market factors.

The Commission is now considering the desirability of recommending amendments to the Atomic Energy Act to eliminate the statutory requirement for Government ownership of special nuclear material. In these considerations the Commission, together with other appropriate agencies of the Government, is paying particular attention to the primary and essential aspects of maintaining effective international safeguards under civil agreements for co-operation with other countries, under the International Atomic Energy Agency, and under disarmament proposals. It would also be necessary that Government control of special nuclear material within the United States, pursuant to licensing and regulatory procedures under the Atomic Energy Act, be continued if private ownership is permitted. The Commission is also considering what transition measures would be necessary over a period of time if a change were made from Government to private ownership of special nuclear material. For example, if the requirement of Government ownership of plutonium and U-233 produced in privately-owned plants in the United States were to be ended, at the time the A.E.C. might well find it advisable to announce its willingness to buy these materials produced in such plants at their fuel value for a few years beyond June 30, 1963, until a free market could be established.

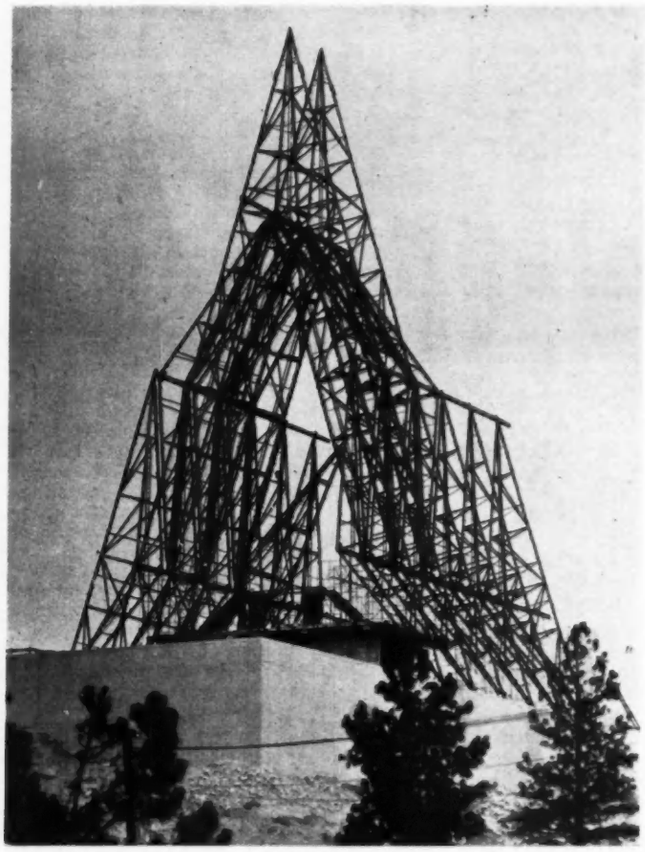
If the estimated fuel values of plutonium and U-233 were related to the revised charges for enriched uranium by the method used previously, they would be reduced by about 20 per cent. This would mean that the fuel value would decrease from 12 dollars to about 9·50 dollars per gramme of plutonium as metal and from 15 dollars to 12 dollars per gramme of U-233 as nitrate. These are calculated as energy values, based on the relative heat release per fissionable nucleus consumed by fission or other nuclear reaction and do not take into account the relative costs of fabricating or processing the various fuels or the amounts of new fuel generated during irradiation. The former tends to decrease and the latter to increase the fuel values of plutonium and U-233. Studies of the relative fuel values of plutonium, U-233, and U-235 for various reactor types are in progress at A.E.C. reactor laboratories, and the results are being published as they are obtained.

THE AMERICAN SCENE *(Continued)*

Steel Pipe Structure for U.S. Air Force Academy Chapel

ONE hundred tetrahedral-shaped supports made of steel pipe have been erected to form the many-spired chapel at the United States Air Force Academy, in Colorado Springs, Colorado. Believed to be the first support structure of this kind, the 75ft long tetrahedrons were fabricated from Republic Steel 4in and 6in diameter steel pipe. The completed chapel will resemble a series of spires pointing skyward, each triangular shape standing single file in a row with the other. The points of the sections in a full view forming the side look like a ridge of gleaming knife blades. Each "spire" is designed by joining four of the tetrahedrons to form an inverted-V shape. Two of the four tetrahedrons form each leg—the bottom of the inverted-V. The other two tetrahedrons in each V-shaped section, meeting the top, form the spire point. The remaining tetrahedrons will be inserted in wedge-fashion between the edges of the "spires" to complete the unique design and help form the shape of the building. By exposing the seventeen spires to the elements, the design of the chapel will be severely tested in place. The steel pipe framework has been designed to withstand the high-velocity winds that emanate from the Rampart Mountain Range.

With regard to fabrication, the use of steel pipe was a significant consideration. Unlike more conventional structural forms that can be put together from I or H beams, the tetrahedrons called for fabrication of complicated mitre joints. However, the use of pipe greatly facilitated the handling of the unusual precision joints. The pipes were cut to proper length and welded into shape with the aid of special welding patterns for the torches and special jigs for holding and turning the pieces during assembly. To each tetrahedron, frame steel angles were welded to hold the chapel skin in position. The attachments are less complex with the cylindrical surface than would be possible with the ordinary structural forms. The curtain-wall construction panels were fitted on to the pipe skeletons and hoisted into position. The larger diameter pipe was employed as primary structural members of the tetrahedrons while the smaller diameter pipe was used as cross-members in support.



Inverted "V"-shaped spires of U.S. Air Force Academy chapel made up of steel pipe tetrahedrons

Tagus River Suspension Bridge, Lisbon

The United States Steel Export Company, of New York, and the Portuguese Government recently signed a contract for the construction of what will be the longest suspension bridge in Europe. The bridge will cross the Tagus River at Lisbon and will take four years to build. It will be a four-lane highway bridge.

The Tagus River Bridge will be the fifth longest clear span bridge in the world. With the main structure stretching nearly 2 miles, the bridge will have a central span of 3318ft and two side spans of 1540ft each. The entire project, including access roads, will encompass more than eight miles of roadway, including many grade-separation structures. The length of the bridge from anchorage to anchorage will be 7428ft and its deepest pier will extend 270ft from the surface of the water to bedrock, and will require excavation and foundation construction to record depth. The depth of the water is approximately 90ft. The main steel towers will support the central span 230ft above mean-tide level to permit the passage of the largest ships and will rise 625ft above the water or 895ft above solid rock.

The U.S. Steel Export Company is the prime contractor for the project which was designed by the firm of Steinman, Boynton, Gronquist and London, of New York, and the Tudor Engineering Company, of San Francisco. The American Bridge Division of United States Steel will fabricate the structural steel for the main bridge structure, and the Portuguese steel fabricating firm, Sociedade Reunidas de Fabricacoes Metalicas, Lda., (S.O.R.E.F.R.A.M.E.) will also participate. Construction of the main piers and approach roadways will be undertaken by the International Morrison-Knudson Company, and its French associates, Compagnie pour l'Etude et le Développement des Echanges Commerciaux (C.O.M.P.A.D.E.C.), who are specialists in deep-water work. For some time the Portuguese Government and U.S. Steel Export have been conducting underwater investigations, including a comprehensive boring pattern, to confirm and fix the final measurements of the bridge, and to study various alternative designs proposed for adoption. As a result of these studies, the Portuguese Government decided on the construction of a four-lane highway bridge, with provisions for the future installation of a double-track railway.

Artist's impression of new suspension bridge over the Tagus river at Lisbon

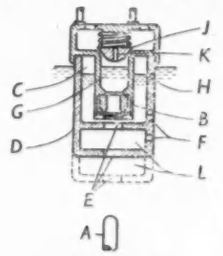
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

ELECTRICAL ENGINEERING

869,787. October 7, 1959.—OIL-BLAST CIRCUIT BREAKER FOR HIGH CURRENTS, Allmanna Svenska Elektriska Aktiebolaget, Vasteras, Sweden.

By this invention an extinguishing chamber for an oil-blast electric circuit breaker is obtained, in which a heavy flow of oil begins along the arc and out through the nozzle of the stationary contact at about the same time as the magnitude of the current passes through zero for the first time. The extinguishing chamber according to the invention also has the advantage that the arc is not drawn out through a wall of insulating material before the extinguishing of the arc begins. The circuit breaker operates in the following way. When, on the occasion of a breaking action, the movable contact *A* (see drawing) leaves the stationary nozzle-shaped contact *B*, an arc is formed which generates gas forming in a bubble around the point of interruption. This gas bubble forces aside the surrounding oil with the result that the oil level below the annular space *C* rises and the gases in this space are compressed. When the value of the interruption current approaches zero the pressure in the gas bubble around the arc decreases and the oil in the extinguishing chamber *D* is forced against the arc and out through the stationary nozzle-shaped contact *B* by the gas pressure in the annular space so that the arc is extinguished. In the open position of the circuit breaker the extinguishing



No. 869,787

chamber is again filled with oil which flows in through the openings *E* and *F*. To ensure that the oil below the annular space and in the outlet channel *G* will always rise to the original levels after a breaking action, the extinguishing chamber has been provided with the oil level opening *H* and the stop valve *J* with the channel *K*. Without these the extinguishing chamber and the outlet channel might, after repeated breaking actions, become gradually filled with breaking gases. On interruption of a lower current the pressure in the extinguishing chamber at first is so low that the stop valve *J* is closed. Because of this the pressure in the annular space is increased more rapidly, and to a sufficiently high value for an effective extinguishing of the arc. When the value has been reached, the gases in the annular space exert such a pressure on the oil in the extinguishing chamber that the stop valve is opened and the extinguishing flow of oil out through the stationary nozzle-shaped contact begins. To make extinguishing of the arc still more certain the movable contact is drawn through one or more oil pockets *L* in the bottom of the extinguishing chamber. On the interruption of high currents, on the other hand, such a high pressure may occur in the extinguishing chamber that it might be in danger of exploding. To prevent this, pressure equalising openings *F* have been arranged in the lower part of the extinguishing chamber.—*June* 7, 1961.

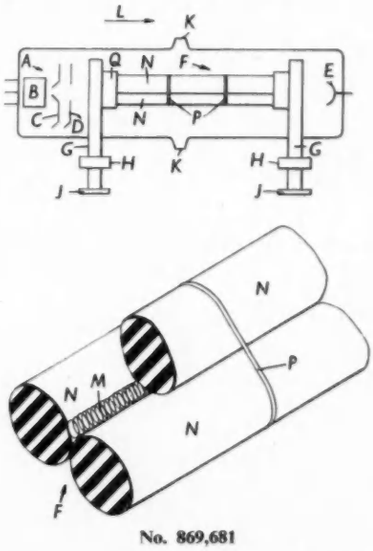
869,108. August 13, 1956.—CONTROL SYSTEMS FOR WINDERS, HOISTS AND THE LIKE, Associated Electrical Industries, Ltd., 33, Grosvenor Place, London, S.W.1. (*Inventor : Roy Lowther.*)

This invention relates to electrical control systems for winders, hoists, lifts and other conveyances of the kind which are hauled by a cable, chain or like element. The control system is responsive to movement of the conveyance so as to govern or limit its motion, and includes a tape, ribbon, or similar flexible element having driving means coupled with the conveyance so as to be moved with the latter, and signal-responsive means co-operating with the element, on which are impressed signals to which the signal-responsive means are designed to respond to control the motion or position of the conveyance. In order that the flexible element shall represent the position of the cage independently of the position of the latter with respect to the driving means, the element is positively driven from a pulley which is in engagement with and driven by the hauling rope, cable or chain for the conveyance. The flexible element may comprise magnetic material, or may comprise a photographic film or other tape, the signal-responsive means being light responsive, for example a light source and a photo-electric cell. In carrying out the invention, the flexible element may conveniently be arranged adjacent the pit-head gear or in the control room of a winder, lift or hoist for example, and may be wound on spools or reels so as to be moved past the co-operating means in accordance with the position of the conveyance. The invention also comprises an electrical control system, in which the signal-responsive means initiates successive discrete changes in the controlled or permitted velocity of the conveyance in response to different signals. Thus it may provide automatic control or limitation of acceleration or retardation, or both acceleration and retardation of the conveyance in predetermined manner.—*May* 31, 1961.

TELECOMMUNICATIONS

869,681. March 25, 1960.—TRAVELLING WAVE TUBES, Standard Telephones and Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2. (*Inventor : Borivoje Minakovic.*)

This invention relates to slow-wave structures for travelling wave tubes. The term " travelling wave tube " is to be taken to include backward wave oscillator tubes in which the mode of propagation in the slow-wave structure is such that the flow of energy is oppositely directed to the flow of the interacting electron stream. The slow-wave structure is arranged similarly to that in the normal travelling wave amplifier except that the output is taken from the end of the slow-wave structure adjacent the electron gun. Conventional methods for supporting the helix in a travelling wave tube are quite successful and convenient up to frequencies of about 20 kilomegacycles per second. For use at higher frequencies the dimensions of a helix are such that a wire helix becomes very flimsy and its support presents a serious problem. In the present invention a wire helix is supported by three surrounding parallel dielectric rods each touching one another and contacting the helix so that the helix rests in the space between the three contacting rods. The upper drawing is a diagram of a travelling wave tube according to the invention. An electron gun *A*, represented by a cathode *B*, focusing electrode *C* and anode *D*, is housed at one end of an evacuated



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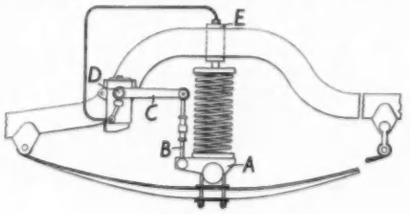
envelope of non-magnetic metal. At the other end of the envelope there is an electron collector electrode, represented at *E*. Between the gun and the collector is a slow wave structure *F*, to be described below, mounted about the electron beam path between respective input and output rectangular waveguides *G*. These waveguides are fitted with hermetic sealing windows *H* and terminals in flanges *J* for connection to other waveguides. To allow for differential thermal expansion of the parts between the waveguides, the envelope is provided with an expansion joint *K*. In operation the electron beam is confined to its desired path by an axial magnetic field represented by the arrow *L*. The slow wave structure comprises a conductive helix *M* (lower drawing) supported by three surrounding parallel rods *N* of low loss dielectric material such as quartz. The rods which may be held together by metal circlips *P* are mounted at their respective ends in collars *Q*, each joined to one of the waveguides. Helix *M* fits in the space between the rods *N* so as to be tangential to each of them. If *D* be the diameter of each rod and *d* the diameter of the helix, the diameter *D* must be so chosen that : $D = 6{\cdot}464\ d$, approximately. The slow-wave structure of the invention is rigid and self-aligning ; furthermore, there is no danger of squashing or distorting the helix when fixing securing means such as circlips.—*June* 7, 1961.

ROAD VEHICLES

870,037. August 12, 1959.—ROAD VEHICLE SUSPENSION SYSTEMS, Armstrong Patents Company, Ltd., of Eastgate, Beverley, Yorkshire. (*Inventor: Ronald Sidney Dickinson.*)

This invention is essentially concerned with a leaf spring suspension wherein means are provided for varying the attitude of a leaf suspension spring to maintain a vehicle frame at a substantially constant height relative to the wheel mounting, and impart a substantially constant riding height to the vehicle. The suspension system shown in the drawing comprises a conventional semi-elliptic leaf spring with the axle secured to its mid-region. The axle carries a transversely extending platform *A* which at its outer end has pivotally secured one end of an adjustable link *B* of which the other end is pivoted to the free end of the control arm *C* of a double-acting lever shock absorber mounted on the vehicle frame. Secured directly above the platform on the frame is a hydraulic cylinder *E* with its ram carrying a cup support for a coil suspension spring. The platform has a complementary spring support cup. The shock absorber (described in Patent No. 867,514) has a pair of parallel cylinders arranged side-by-side, each housing a piston. Rods extending from the pistons are secured to a common yoke carried on a semi-rotary shaft *D* arranged for displacement by the lever *C*.



No. 870,037

When the vehicle is in motion, the normal damping movements of the shock absorber pistons in their cylinders are employed to allow either or both pistons to act as a pump for transferring hydraulic medium to the hydraulic cylinder *E*. When a relief valve is open this pumping action is rendered ineffective and the hydraulic cylinder is permitted to exhaust fluid into the reservoir. To enable the relief valve to act as a means for so controlling the pumping and exhaust operations as to maintain the vehicle frame at a desired mean riding height, the yoke connecting the shock absorber pistons, or the semi-rotary shaft *D*, on which it is carried, may, through cams, open and close the relief valve responsive to the movement of the shock absorber control arm away from a predetermined mean position. By appropriate positioning of the cam, when the load on the vehicle is increased, the ram of cylinder *E* may be extended to compress the auxiliary coil spring and raise the vehicle frame relative to the axle and compensate for decrease in vehicle riding height. Conversely, as the load is decreased, the relief valve may partly exhaust its hydraulic medium into the shock absorber reservoir so that the ram retracts into cylinder *E* and the coil suspension spring is allowed to expand.—*June* 7, 1961.

GASIFICATION PLANT

870,150. March 10, 1959.—OIL GASIFICATION PLANT, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15, and George Le Boutillier Diamond, of the Company's address.

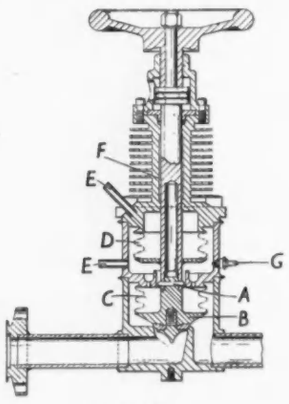
This invention is concerned with oil gasification plant adapted for cyclic operation, that is to say plant in which a gas-making period alter-

nates with a heat-restoring or blow period for replacing stored heat used during the gas-making period and for burning off carbon deposited in gas making. In one method of producing gas from oil, the oil is sprayed, during the gas-making period into superheated steam with which it reacts in the presence of a catalyst to produce the gaseous fuel. Oil sprayed directly on to the catalyst bed has been found to result in rapid deterioration of the activity of the catalyst and heavy deposition of ash which blocks the gas passages through the bed. Oil sprayed into the chequer-brickwork of a preheater through which the steam passes avoids this difficulty but the thermal shock suffered by the refractory brickwork when cold oil comes into contact with it is considerable. According to the invention oil is passed continuously through a preheating zone so that its temperature is raised to a value such that the oil introduced into the plant during gas-making periods is in a volatilised state. Some of the oil flowing through the preheating zone during blow periods circulates continuously. Preheating of the oil before it is introduced into the plant ensures that cold, liquid oil does not come into contact with the catalyst bed or the refractory chequer brickwork of the steam preheater or other part of the gasification plant. Moreover volatilisation of the oil tends to minimise deposition of carbon. The oil may be in a volatilised state before it reaches the nozzle through which it is introduced into the plant, or, alternatively, it may be volatilised on expansion through the nozzle. It is sufficient to preheat the oil to a temperature such that in a liquid state it does not reach hot parts of the plant, such as the refractory brickwork. During blow periods some of the oil flowing through the preheating zone may be supplied to a burner which heats the air passed through the plant. The remainder of the oil, or all of it if none is tapped during the blow period, is circulated to avoid decomposition. The specification illustrates and gives constructional details of a typical plant.—*June* 14, 1961.

VALVES

869,101. November 11, 1959.—FLUID CONTROL VALVES, Hawker Siddeley Nuclear Power Company, Ltd., Sutton Lane, Langley, Near Slough, Bucks. (*Inventor: Christopher Elderfield.*)

The valve shown in the drawing is suitable for use with hot liquid metal such as bismuth, which may be dangerously radioactive, or for controlling the flow of other fluids. The construction of the valve is such that accidental escape of fluid is minimised or prevented. The valve operating shaft is made non-rotatable by the pin *A* which secures the valve sealing member *B* and rides in grooves in the body. Two bellows, *C* and *D*, seal the shaft in the casing and prevent escape of the fluid from the valve. In normal operation the fluid does not pass the bellows *C*, but should this fail the escape of fluid is prevented by the second bellows *D*. Since the fluid being controlled



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by the valve may be at a pressure above atmospheric, the pressure differential across the bellows *C* can be reduced by application of pressure through the conduits *E*. In the event of failure of the bellows *D*, liquid metal passes between the periphery of the shaft and the casing and in the annular aperture *F* is cooled and solidifies; the cooling fins assisting the dispersal of heat. The solidified metal in the annular aperture effectively prevents further escape from the valve. The valve remains operable even when the bellows *C* has failed. After failure of bellows *D* the solidifying of liquid metal in aperture *F* prevents furthes operation. In order to give a visual and/or audible indication of the failure of the bellows *C* a device *G*, similar to a spark plug, is provided in the wall of the valve casing. Two electrodes on this device are bridged by the liquid metal and complete an electric circuit to provide warning.—*May* 31, 1961.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

GALVANISED MILD STEEL WIRE FOR ARMOURING CABLES.

No. 1442 : 1960. Price 4s. This revised standard now applies only to galvanised mild steel wire used primarily for the armouring of land cables for electrical purposes. Requirements for galvanised mild steel wire for the armouring of submarine cables have been transferred to B.S. 1441, which is to be published soon.

In the previous edition of this specification, the resistivity of the wire was stated as an ohm/mile constant, but it was not a specified requirement. However, with the increasing use of non-metallic sheathed cables in which the wire armour serves as the sole earth continuity conductor for certain purposes and types of cables, the resistance of the armour becomes important. Therefore, in the revised edition, there is a clause stating that for certain purposes and by agreement between purchaser and manufacturer, the d.c. resistance of the galvanised wire shall be measured. Maximum resistance figures are given for each of the sizes of wire and for convenience are expressed in ohms per 1000 yards of wire at 20 deg. Cent. (68 deg. Fah.).

The standard applies to fully galvanised mild steel round wire in sizes ranging from 0·160in to 0·018in. Tests and tolerances are specified and details are provided relating to the preferred sizes, the selection and testing of test samples, r -tests, galvanising, resistivity, and packing and identification.

TUBULAR FLUORESCENT LAMPS FOR GENERAL LIGHTING SERVICE

No. 1853 : 1960. Price 7s. 6d. The 1956 edition of this British Standard covered tubular fluorescent lamps used in switch-start circuits only. The standard, as now revised, covers lamps suitable for use both on switch and switchless start circuits. It also includes requirements for 80W lamps with bi-pin caps and 125W lamps with bayonet and bi-pin caps. As in the 1956 edition, the arrangement of the clauses is similar to that adopted by the International Electrotechnical Commission (I.E.C.) for standards for electric lamps. The quality levels are controlled by means of the proportion of lamps in a batch falling outside prescribed limits. The foreword to the standard states that "lamps falling outside the specified quality levels are not necessarily failures or faulty lamps, but their numbers serve to determine the level of quality." The standard specifies technical requirements and methods of test to be used for determining the quality and interchangeability of the lamps.

GUIDE TO CIVIL LAND AERODROME LIGHTING

No. 1332 : 1960. Price. 12s. 6d. This British Standard guide, first published in 1932, has been revised to take account of international agreements and developments in the aviation field. It is based on Annex 14 (third edition, 1958) of the International Civil Air Organisation. The guide describes the various types of aerodrome lights and their use at civil land aerodromes to meet the operating requirements of fixed wing aircraft. Since no international standards yet exist for lighting for helicopter stations, recommendations for this have not been included, but it is hoped to add them at a later date. The twelve parts cover definitions, general requirements, beacons, approach lighting, angle of approach indicator systems, runway lighting, circling guidance lighting, taxiway lighting, taxying guidance, obstruction lighting, luminous landing direction indicators and lighting at grass aerodromes. Among the lights described are forms which have recently been included in Annex 14, but are still in various stages of development and operational evaluation: in particular, circling guidance lights and runway surface lights. Section 5, on angle-of-approach indicators, covers both the three-colour and two-colour systems and summarises the advantages of the latter, which is now being installed at a number of airports in the United Kingdom, and, following flight trials in America, has been adopted by the Federal Aviation Agency. Full-page diagrams show recognised approach lighting patterns, an elevation and plan of the two-colour angle of approach indicator system, the recommended pattern for runway surface lights, and the location of circling guidance lights in relation to a runway and its approach lighting.

SAMPLING SUPERHEATED STEAM FROM STEAM GENERATING UNITS

No. 3285 : 1960. Price 7s. 6d. The increasing use of boilers operating at higher pressure has created a need for the standardisation of sampling and testing methods for superheated steam, since the purity of the steam cannot always be accurately predicted from the composition of the water from which it is generated. In this British Standard the best—and, therefore, frequently the most difficult—techniques are given. The publication is complementary to Addendum One of B.S. 2690, "Methods of Testing Water Used in Industry," which was specifically prepared for the analysis of high purity water and is due to be published shortly. B.S. 3285 states requirements for apparatus and for procedure for obtaining a representative sample of superheated steam flowing in a pipe or pipes. It also covers the extraction and processing of the sample, for delivery to measuring and analytical devices suitable for continuous field testing or for delivery to a container in which the sample may be preserved for subsequent laboratory investigation.

Catalogues and Brochures

COPPER DEVELOPMENT ASSOCIATION, 55, South Audley Street, London, W.1.—Brochure entitled "Copper Bearing Steels for Structural Purposes." Copper bearing steels are not new, but they are not as widely used as they could be or, as the foreword to this brochure points out, as they should be. A small percentage of copper—0·2 to 0·5 per cent—of copper in steel effects a very marked improvement in the material's corrosion-resisting properties, and since the proportion of copper is so low, the cost of the steel is only increased slightly. Evidence is produced in the brochure to show that with an increase of only 5 per cent in the initial cost, copper steels have a life of 50 to 100 per cent longer than an equivalent mild steel. The addition of copper to a structural mild steel is optional in present British Standards, and copper steels are used in the same way as ordinary mild steel; mechanical properties are only affected to a minor degree by the addition of copper.

It is also possible to add copper, with its beneficial effects on corrosion resistance, to low-alloy steels, which have a yield strength 50 per cent higher than ordinary mild steel. This type of low alloy steel is available, under the name "Cor-Ten," in Great Britain as well as the U.S.A., where it originated. Copper bearing steel are not difficult to make, but as the brochure points out, they will only be produced in the quantities demanded by the user. The brochure provides adequate technical information for an assessment of the value of copper bearing steels from a user's point of view, and produces some cogent reasons for an extension of their employment.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., July 10.—CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, London, W.C.1, "Modern Motors and their Control," 7.15 p.m.

Wed., July 12.—LUTON BRANCH: Luton College of Technology, Park Square, Luton, "Colour Television," P. S. Carnt, 8.15 p.m.

Thurs., July 13.—SOUTH WEST LONDON BRANCH: Prince of Wales Hotel, London, S.W.19, "Electric Motor Control Gear," R. F. Mathieson, 7.45 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day to Sun., July 7 *to* 9.—1961 Convention: Christ Church, The University, Oxford, "Radio Techniques and Space Research."

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Tues. to Thurs., July 11 *to* 13.—Open Days at the Building Research Station, Garston, Watford, Herts.

Advanced Engineering Courses

Current Practice in Fuel Efficiency. NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE, SOUTH WESTERN AREA, Ailsa House, 181, King's Road, Reading. Eighth annual refresher course to be held at The Clarendon Laboratory, Oxford, from September 25 to 29. The course covers a wide range of subjects and presents an opportunity for works managers, works and plant engineers, and technical staff of industrial, municipal and public undertakings to acquire up-to-date information on developments and research into the more efficient use of fuels, plant and processing. Fee, covering course, accommodation and meals, £16 16s.

Statistical Quality Control and Acceptance Sampling. THE COLLEGE OF ADVANCED TECHNOLOGY, Birmingham. A full-time course of three weeks' duration commencing Monday, September 11. The course is primarily intended as an introduction to the subject, but nevertheless provides the basic training necessary for quality control engineers. The first fortnight will be spent in covering the general principles and procedures of quality control. The final week will be devoted to lectures by specialists from industry, and to visiting the works of firms employing quality control, where members of the course will be able to see the practical application of quality control methods, and discuss the techniques and associated problems.

BOROUGH POLYTECHNIC, Borough Road, London, S.E.1. **Modern Developments in Non-destructive Testing of Metals.** A course of six lectures, given by specialists from industry on consecutive Wednesday evenings at 7 p.m., commencing October 4. Fee 10s. Type of student: metallurgists, engineers and others interested in this field.

Refractories, their Manufacture, Properties and Uses. A course of ten lectures, given by L. R. Barrett, A.R.I.C., M.Inst.F., F.Inst.Ceram., on consecutive Friday evenings at 7 p.m. commencing October 6. Fee £1. Type of student: metallurgists, chemists, engineers and others engaged on work involving the use of refractory materials.

Recent Advances in Semi-Conductor Metallurgy. A course of six lectures given by A. S. Abrahams, A.I.M., on consecutive Tuesday evenings at 7 p.m., commencing October 24. Fee £1. Type of student: metallurgists, physicists, electrical engineers and others engaged on research and development work in this field.

Corrosion and Protection of Buried Metals. A course of six lectures, given by specialists from industry on consecutive Thursday evenings at 7 p.m., commencing November 2. Fee 10s. Type of student: metallurgists, chemists, civil engineers and others engaged on work in this field.